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Office of the Environmental Protection Authority
Locked Bag 10
EAST PERTH WA 6892
Broome WA 6725

11 December 2013

Attention: Ms Amy Sgherza (Assessment Officer)

RE: Notice requiring further information- Development on Lot 616, Lot 1221 and Port Drive Road Reserve (Ref: AC01-2013-0007)

I am writing in response to your request for further information on the development on Lot 616, Lot 1221 and Port Drive Road Reserve received on the 3 December 2013. The proposed development was referred under *section 38A of the Environment Protection Act 1986* to the EPA by a third party in November 2013. The EPA is therefore required to determine the impact of the project on the environment, whether or not to assess the proposed development and if the decision is to assess, the level of assessment.

Further to the above request for further information the EPA supplied Coffey and Broome Port Authority (BrPA) with the below information as provided to the EPA by the third party.

"With regards to CPS 3104/4, the clearing proposed for this area has the potential to destroy a significant proportion of the remaining PEC Relict dune system dominated by extensive stands of Mangarr, another priority 1 PEC is likely to exist in this area 'Corymbia paractia dominated community on dunes'. The percentage proposed to be cleared by the Broome Port Authority proposal is unknown." And

"The proposal includes clearing vegetation on Lot 1221 and replacing with hardstand and buildings. This is likely to result in significant stormwater run-off and this could have an impact on the Roebuck Bay mudflats threatened ecological community Species-rich faunal community of the intertidal mudflats of Roebuck Bay (Vulnerable)."

Coffey and BrPA acknowledges the concerns of the third party in relation to the above matters however feels that these issues have been investigated adequately through comprehensive technical assessments (including targeted flora and fauna assessments) which have been conducted in accordance with the relevant EPA guidance statements. It should also be noted that the proposed development was referred to the Department of the Environment (DoE) under the *EPBC Act 1999* and was not considered a controlled action if undertaken in a particular manner (Attachment B). The proposed development was also assessed under the *Native Vegetation Clearing Regulations 2004* and granted a permit under *section 51E of the Environmental Protection Act 1986* (Attachment C).

Despite this the EPA has considered it does not have enough information about the proposed development to enable it to make a decision on its significance and appropriate level of assessment and has therefore requested the following information:

1. Details of the proposal.
2. Potential environmental impacts likely as a result of the proposal.
3. Details of any existing or pending approvals for the proposal.
4. Implementation stage of the proposal.
5. Electronic spatial data.

The above information has been summarised in this response and electronic spatial data (in the format specified by the EPA) has also been provided for your reference. Technical assessments and relevant environmental approval documents have also been attached to this response for further information on the proposed development and associated environmental impacts.

1. Details of the Proposal

BrPA is proposing to clear approximately 24.55 ha of native vegetation within Lot 616, 1221 and Port Drive Road Reserve in order to establish a washdown facility, supply bases to support exploration of the Browse Basin and ancillary small businesses. A map of the proposed development area has been provided in Attachment A. The proposed development is located within the Port of Broome Industrial precinct in an area already highly developed.

The rationale for the location of the washdown facility and the supply bases within BrPA-managed land is as follows:

- Locating the washdown facility close to the BrPA jetty minimises the road journey between ships and the inspection facility and reduces the need for transporting oversize and/or heavy loads through the Broome Township.

  A washdown facility is a highly desirable piece of infrastructure to have if Broome Port is to develop a container transport business and take trucks off the road between Broome, Perth and Darwin.
- Establishment of a washdown facility is a likely prerequisite for any future liquefied natural gas (LNG) precinct in the Kimberley region.
- Locating the supply bases close to the jetty minimises transportation risks, costs and impact to the Broome community.

As outlined in the map provided in Attachment A, Lot 616, Lot 1221 and Port Drive Road Reserve consists of a larger northern section and a smaller eastern section.

The larger northern section will be used for the construction and operation of the washdown facility and supply bases. Specifically, this area will contain:

- Warehousing and container laydown areas.
- Logistic transport nodes.
- Storage areas for drilling equipment, general stores, casing and pipe.
- Storage areas for sundry equipment used by oil rigs and their supply vessels, including, but not limited to chain, anchors, drill casing, drills, safety equipment, chemicals and small amounts of explosives.
- Repair and maintenance workshops.
- Administration offices.

The smaller eastern section will be used for the establishment of ancillary small businesses.

2. Potential environmental impacts likely as a result of the proposal

Flora and Vegetation

A number of flora and vegetation surveys have been undertaken in the proposed development area. Woodman (2008) undertook a Level 2 flora assessment of all BrPA-managed lands (including Lots 616, 1221 and Port Drive Road Reserve) and identified several FCTs within BrPA-managed land. However, all the proposed clearing will occur within FCT 4. The total known area of this FCT is approximately 218 ha within all of the BrPA-managed lands, of which no greater than 24.55 ha or 12 % of this community is proposed to be cleared (Woodman, 2008). Therefore, impacts on this FCT as a result of the proposed development are likely to be negligible. In addition, no TECs or PECs were recorded in the proposed development area during the Level 2 flora survey. It should also be noted that BrPA has surrendered approximately 50 ha of high heritage and cultural value into reserves.

Populations of *Keraudrenia exastia* (Critically Endangered) are known from 50 m south and 20 m north of the proposed development area. This species does not occur within the proposed development area and BrPA has ensured that a 50 m buffer is maintained around this species in order to minimise indirect impacts such as dust. A *Scleria* sp. recorded from the proposed development area was previously thought to be a new taxon however this species has been clumped into the *Scleria brownii* complex and is not of conservation significance.

A site investigation of the proposed development area was conducted by Coffey Environments in 2013 (Coffey Environments, 2013a, 2013b) in order to identify any botanical constraints within the approved area to be cleared under Native Vegetation Clearing Permit (NVCP) CPS 3104/4 (Attachments D & E) (Coffey Environments, 2013a, 2013b). The site investigation identified forty-six individual Mangarr (*Sersalisia sericea*) trees from the Port Drive West survey area, of which fifteen were located within the proposed development area (Attachment A) (Coffey Environments, 2013a). However, the presence of this species does not necessary represent the presence of the P1 PEC Mangarr Community (Coffey Environments, 2013a).

Fauna

Some loss of fauna habitat (i.e., no greater than 24. 55 ha of FCT 4) will occur during clearing and it is possible that the habitat could contain species of conservation significance. However, fauna habitat within the proposed clearing area is widespread across BrPA-managed land and the known conservation significant species are not locally restricted or reliant on this habitat.

The impact of the proposed development on fauna is considered to be low, as per definitions contained with EPA Guidance Statement 56 (EPA, 2004).

Roebuck Bay mudflats

The Roebuck Bay mudflats (faunal mudflats community) is located approximately 3 km northwest of the proposed development area and is separated from the community by infrastructure and potential secondary impacts (such as altered hydrology and dust) are considered to be negligible given the intertidal nature and large extent of the ecosystem.

3. Details of any existing or pending environmental approvals

The proposed development has been referred under the *EPBC Act 1999* and *Schedule 5 of the EP Act* (*Clearing of Native Vegetation Regulations 2004*). A copy of the decision report for the EPBC Referral (EPBC 2012/6364) and NVCP (CPS 3104/4) has been provided in Attachment B and C.

Details of existing or pending environmental approvals for the proposed development and compliance against approval conditions are presented in Table 1.

Please note that Native Vegetation Clearing Permits (NVCPs) CPS 3104/2, CPS 3104/3 have been superseded by CPS 3104/4 which is the current live permit for the proposed development area. A separate NVCP application for entry points into the proposed development and commercial development along Port Drive Services Easement was also submitted to the Department of Environment Regulation (DER) in November 2013 and is currently under assessment.

NVCP CPS 4727/1 is not related to the proposed development area and is a live permit for the purpose of fire hazard reduction located to the south of the proposed development area. Due to the size of the clearing area and negligible environmental impact this permit did not contain any conditions.

Table 1 Existing and pending environmental approvals

Relevant Legislation	Approval Document	Duration	Details	Status	Compliance with approval conditions
Environmental Protection Act 1986 *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*	Native Vegetation Clearing (Purpose) Permit (CPS 3104/4)	24 October 2009 to 24 October 2014	Clearing of 24.55 ha on Lot 616 and 1221 for the purpose of commercial development and relocation of utilities corridor.	Live	Yes
	Native Vegetation Clearing (Purpose) Permit (CPS 4727/1)	6 February 2012 to 6 February 2014	Clearing of 0.6 ha on Lot 956 for fire hazard reduction.	Live	No conditions
	Native Vegetation Clearing (Purpose) Permit (CPS 5873/1)	13 November 2013 to 13 November 2018	4.25 ha at entrance point, Lots 534, 535 and 548 and Port Drive Services Easement for the purpose of commercial development.	Pending	NA
Environment Protection and Biodiversity Conservation (EPBC) Act 1999	EPBC Referral (EPBC 2012/6364)	Approval granted on 7 December 2012	Clearing on Lot 616 and 1221 for the purpose of commercial development and relocation of utilities corridor.	Not controlled action if undertaken in particular manner	Yes

4. Implementation stage of the proposal

Ground disturbance for the proposed development has not yet occurred. Development approvals for approximately 1.15 ha of land on the south eastern portion of the approved lots are well advanced and subject to Shire approval of the Development Application (which is expected on 6 January 2014), clearing is expected to take place in the first half of January 2014 with construction commencing shortly thereafter.

5. Electronic spatial data

Electronic spatial data (GIS) has been provided with this response and includes polygons representing the proposed development area, lot boundaries, flora community types and conservation significant flora records. This information has also been displayed in the map provided in Attachment A.

Given that BrPA holds all relevant statutory requirements in order to commence the proposed development and that suitable management and mitigation measures, which have been outlined in BrPAs approved Environmental Management Plan (EMP) (Attachment G) will be implemented to mitigate potential environmental impacts, it is considered that the proposed development does not compromise the principles of ESD and therefore does not require formal assessment by the EPA.

Should you require any further information on the proposed development or any other related matter please do not hesitate to contact Stephen Danti or Martine Scheltema on 9355 7100.

Yours Sincerely,

Stephen Danti
Senior Environmental Scientist

Martine Scheltema
Principal Environmental Consultant

Attachment A: Proposed Development Locality Map
Attachment B: EPBC Decision on Referral (EPBC 2012/6364)
Attachment C Native Vegetation Clearing Permit and Decision Report (CPS 3104/4)
Attachment D: Coffey (2013) Environmental Advice – Port Drive West
Attachment E: Coffey (2013) Environmental Site Investigation – Port Drive East
Attachment F: Woodman (2008) Flora Assessment
Attachment G: Environmental Management Plan

References

Coffey Environments, 2013a. Environmental Advice- Port Drive West. Report prepared by Coffey Environments for Broome Port Authority, June 2013.

Coffey Environments, 2013b. Environmental Advice- Port Drive East. Report prepared by Coffey Environments for Broome Port Authority, April 2013.

EPA, 2004. Guidance for the Assessment of Environmental Factors. Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia No. 56. Guidance Statement prepared by the Environmental Protection Authority, June 2004.

Woodman, 2008. Broome Port Authority – Floristic Community Types of the Broome Peninsula. Report prepared by Woodman Environmental Consulting Pty Ltd for Broome Port Authority, October 2008.

Attachment A

Proposed Development Locality Map

Source & Notes
Mangarr plants from Coffey (July 2013).
Floristic community types, conservation significant flora and conservation significant vegetation from Woodman Environmental Consulting (April 2008).
Aerial imagery from Google Earth Pro.

coffey

Date: 10.12.2013
MXD: 2991AH_01_GIS001_v0_2
File Name: 2991AH_01_F001_GIS

Broome Port Authority

EPA Response

Proposed Development Area

Figure No: **1**

Attachment B

EPBC Decision on Referral (EPBC 2012/6364)

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

Notification of
REFERRAL DECISION – not controlled action if undertaken in a particular manner

The establishment of an Australian Quarantine and Inspection Service (AQIS) washdown facility, Logistics Support Base & ancillary businesses, Broome Port, Broome, Western Australia (EPBC 2012/6364)

This decision is made under sections 75 and 77A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

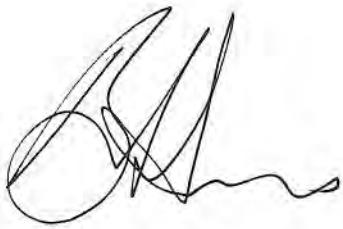
Proposed action

person named in the referral	**Broome Port Authority** ABN 56 780 427 150
proposed action	To construct and operate the Australian Quarantine and Inspection Service (AQIS) Washdown facility, logistics support base and ancillary businesses on Lot 616 and Lot 1221, Broome Port, Broome, Western Australia. [See EPBC Act referral 2012/6364]

Referral decision: Not a controlled action if undertaken in a particular manner

status of proposed action	The proposed action is not a controlled action provided it is undertaken in the manner set out in this decision.

Person authorised to make decision

Name and position	Barbara Jones Assistant Secretary North, West & Offshore Assessment Branch
signature	
date of decision	7 December 2012

manner in which proposed action must be taken	The following measures must be taken to avoid significant impacts on: • Listed threatened species and communities (sections 18 & 18A) 1. **Clearance** and **construction** must only occur on the **Development Area.** 2. Prior to the commencement of **construction**, a permanent security fence (minimum height 2.0m) must be installed around the perimeter of the **Development Area** shown at 'Attachment A'. 3. Prior to the commencement of **construction**, erection of permanent signage at a minimum of 3 locations on the perimeter of the **Proposed Conservation Area shown at 'Attachment A'**, containing information to educate the public and site personnel of the environmental status and value of the Fringed Keraudrenia (*Keraudrenia exastia*). 4. Site sheds, material storage, laydown areas, temporary equipment, vehicle parking associated with **clearance** and **construction** must be located only on the **Development Area.** 5. Prior to **clearance** of vegetation, spray or treat all weed populations in areas on the **Development Area** that are to be used for topsoil or vegetation stockpiles. 6. Undertake compulsory site inductions to ensure that all personnel are made aware of the environmental status and value of the Fringed Keraudrenia (*Keraudrenia exastia*). 7. Undertake dust suppression during **clearance** and **construction** and during any other activity that generates visible dust to minimise impacts on the Fringed Keraudrenia (*Keraurdrenia Exastia).* 8. During **clearance** and **construction**, to control surface water flows, re-contour all disturbed areas on the **Development Area** not required for operational purposes and use shallow ripping to alleviate any compaction. 9. The operation of the Australian Quarantine Inspection Service washdown facility must be undertaken in accordance with the Australian Quarantine Inspection Service **Quarantine Approved Premise Criteria**. 10. Prior to the commencement of **operation** of the Australian Quarantine Inspection Service washdown facility, the person taking the action must ensure that an approved **Contingency Plan,** as required by the Australian Quarantine Inspection Service Quarantine Approved Premise Conditions of Approval, is in place.

Definitions

Clearance: means the cutting down, felling, thinning, logging, removing, killing, destroying, poisoning, ringbarking, uprooting or burning of vegetation.

Construction: means any pre-construction, temporary or permanent activity associated with the proposed action, including but not limited to demarcation, demolition, excavation, erection of onsite structures and the use of equipment for these purposes, but excluding works required to construct security fencing on the perimeter of the site as shown in Attachment A.

Contingency Plan is a plan that details the measures that will be implemented to manage unexpected events that threaten to compromise quarantine integrity, including appearance of pests or symptoms of disease, structural damage, unauthorised removal of quarantine material and spillages of quarantine material.

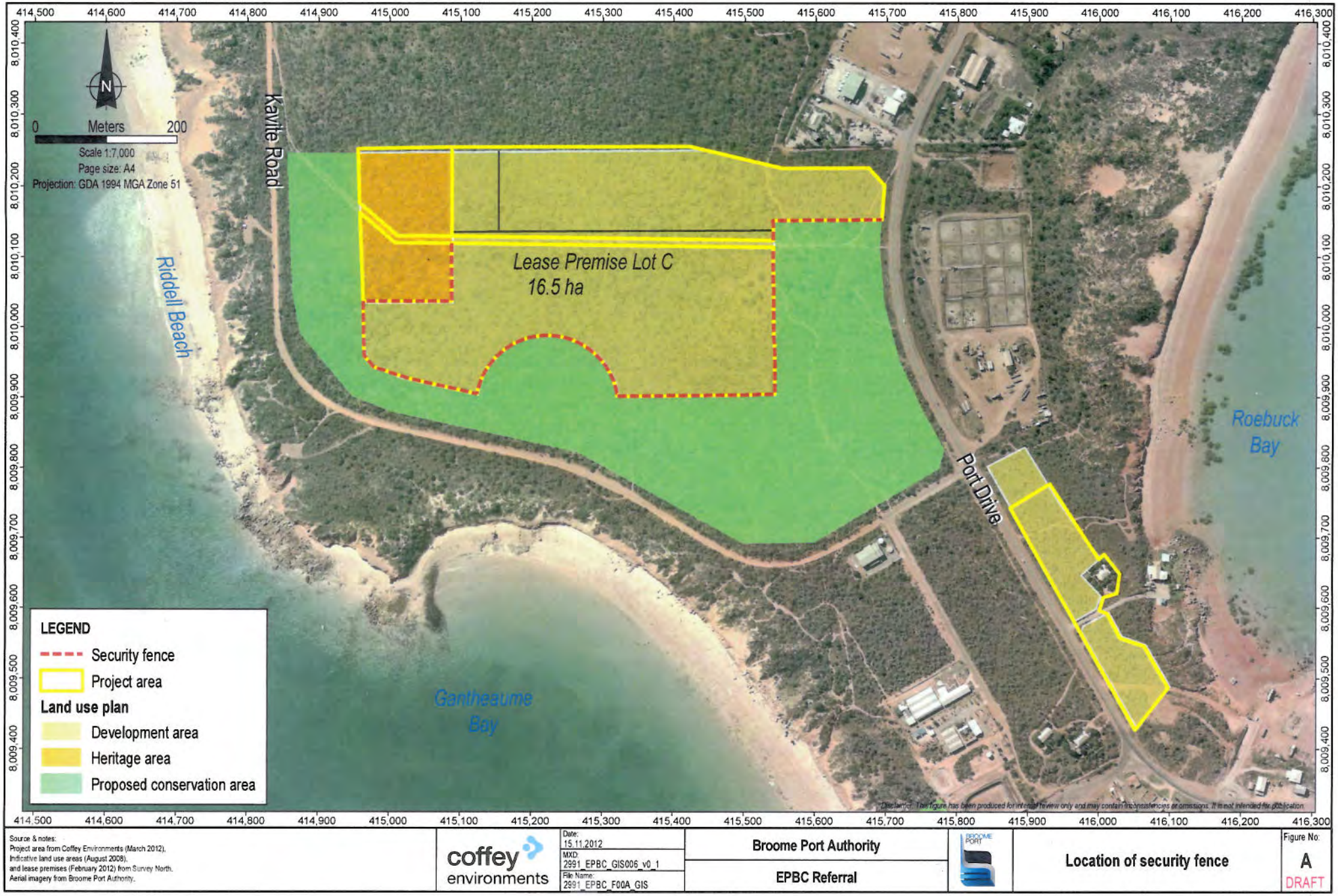
Development Area: is the area highlighted as Development Area at Attachment A.

Proposed Conservation Area: is the area highlighted as Proposed Conservation Area at 'Attachment A'.

Operation is the day to day activities associated with premises where post-entry quarantine activities and treatments may be performed on goods, animals and plants.

Quarantine Approved Premise Criteria are the criteria utilised by the Commonwealth Department of Agriculture, Fisheries and Forestry Australian Quarantine Inspection Service to approve Quarantine Approved Premises (QAP).

ATTACHENT A



Source & notes:
Project area from Coffey Environments (March 2012).
Indicative land use areas (August 2008).
and lease premises (February 2012) from Survey North.
Aerial imagery from Broome Port Authority.

coffey environments

Date: 15.11.2012
MXD: 2991_EPBC_GIS006_v0_1
File Name: 2991_EPBC_F00A_GIS

Broome Port Authority

EPBC Referral

Location of security fence

Figure No: A
DRAFT

Attachment C

Native Vegetation Clearing Permit and Decision Report (CPS 3104/4)

GOVERNMENT OF
WESTERN AUSTRALIA

CLEARING PERMIT

Granted under section 51E of the Environmental Protection Act 1986

Purpose Permit number:	CPS 3104/4
Permit Holder:	Broome Port Authority
Duration of Permit:	24 October 2009 – 24 October 2014

The Permit Holder is authorised to clear native vegetation subject to the following conditions of this Permit.

PART I – CLEARING AUTHORISED

1. **Purpose for which clearing may be done**
   Clearing for the purpose of commercial development, relocation of utilities corridor and relocation of a telecommunications line.

2. **Land on which clearing is to be done**
   Lot 616 on Plan 240107 (Port Minyirr 6725)
   Lot 1221 on Plan 182648 (Port Minyirr 6725)
   Port Drive road reserve (Port Minyirr 6725)

3. **Area of Clearing**
   The Permit Holder must not clear more than 24.55 hectares of native vegetation within the area hatched yellow on attached Plan 3104/4.

4. **Application**
   This Permit allows the Permit Holder to authorise persons, including employees, contractors and agents of the Permit Holder, to clear native vegetation for the purposes of this Permit subject to compliance with the conditions of this Permit and approval from the Permit Holder.

5. **Compliance with Assessment Sequence and Management Procedures**
   Prior to clearing any native vegetation under conditions 1, 2 and 3 of this Permit, the Permit Holder must comply with the Assessment Sequence and the Management Procedures set out in Part II of this Permit.

PART II – ASSESSMENT SEQUENCE AND MANAGEMENT PROCEDURES

6. **Avoid, minimise etc clearing**
   In determining the amount of native vegetation to be cleared authorised under this Permit, the Permit Holder must have regard to the following principles, set out in order of preference:
   (a) avoid the clearing of native vegetation;
   (b) minimise the amount of native vegetation to be cleared; and
   (c) reduce the impact of clearing on any environmental value.

PART III - RECORD KEEPING AND REPORTING

7. **Records must be kept**
   The Permit Holder must maintain the following records for activities done pursuant to this Permit in relation to the clearing of native vegetation authorised under this Permit:
   (a) the species composition, structure and density of the cleared area;

(b) the location where the clearing occurred, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings;
(c) the date that the area was cleared; and
(d) the size of the area cleared (in hectares).

8. Reporting

(a) The Permit Holder must provide to the CEO, on or before 30 June of each year, a written report of records required under condition 7 of this Permit and activities done by the Permit Holder under this Permit between 1 January and 31 December of the preceding year.

(b) Prior to 24 June 2014, the Permit Holder must provide to the CEO a written report of records required under condition 7 of this Permit where these records have not already been provided under condition 8(a) of this Permit.

M Warnock
A/MANAGER
NATIVE VEGETATION CONSERVATION BRANCH

Officer delegated under Section 20
of the Environmental Protection Act 1986

9 August 2012

Department of Environment and Conservation

Clearing Permit Decision Report

1. Application details

1.1. Permit application details

Permit application No.: 3104/4

Permit type: Purpose Permit

1.2. Proponent details

Proponent's name: Broome Port Authority

1.3. Property details

Property: ROAD RESERVE (MINYIRR 6725)
LOT 1221 ON PLAN 182648 (House No. 288 PORT MINYIRR 6725)
LOT 616 ON PLAN 240107 (House No. 401 PORT MINYIRR 6725)
LOT 616 ON PLAN 240107 (House No. 401 PORT MINYIRR 6725)
LOT 616 ON PLAN 240107 (House No. 401 PORT MINYIRR 6725)
LOT 616 ON PLAN 240107 (House No. 401 PORT MINYIRR 6725)
LOT 616 ON PLAN 240107 (House No. 401 PORT MINYIRR 6725)
LOT 616 ON PLAN 240107 (House No. 401 PORT MINYIRR 6725)

Local Government Area:

Colloquial name:

1.4. Application

Clearing Area (ha)	No. Trees	Method of Clearing	For the purpose of:
23.15		Mechanical Removal	Building or Structure
1.4		Mechanical Removal	Water/gas/cable/pipeline/power installation

1.5. Decision on application

Decision on Permit Application:

Decision Date:

2. Site Information

2.1. Existing environment and information

2.1.1. Description of the native vegetation under application

Vegetation Description	Clearing Description	Vegetation Condition	Comment
Beard Vegetation Association 750: Shrublands, pindan; Acacia tumida shrubland with grey box & cabbage gum medium woodland over ribbon grass & curly spinifex (Shepherd et al, 2001)	The application is for the clearing of 24.55 (was 22.65 ha) of native vegetation for commercial purposes and installing underground telecommunications. The vegetation under assessment is classified as being in good to degraded (Keighery, 1994) condition. The vegetation type is open Pindan wattle consisting of Eucalyptus and Acacia species (DEC, 2009a). The amendment area proposed to clear within Port Drive road reserve is classified as being in a degraded (Keighery, 1994) condition. The vegetation consists of open Acacia, Eucalypt and Corymbia Scrubland with scattered Grevillia spp. Bauhinia cunninghamii and Brachychiton spp. Over grassland on pindan soils.	Degraded: Structure severely disturbed; regeneration to good condition requires intensive management (Keighery 1994) Good: Structure significantly altered by multiple disturbance; retains basic structure/ability to regenerate (Keighery 1994)	The vegetation condition was assessed through aerial photography (Broome - Willie Creek 40cm Orthomosaic - Landgate), and survey (Coffey, 2009) and site inspection conducted by the Department of Environment and Conservation (2012a and 2012b).

3. Assessment of application against clearing principles

Comments

The permit has been amended to increase the area of clearing from 22.65 hectares to 24.55 hectares within Port Drive road reserve and Lot 616 on Plan 240107 for the purpose of installing underground power lines and an access track.

The assessment against the clearing principles have not changed, the findings from the previous assessment are still relevant and can be found in the Clearing Permit Decision Report CPS 3104/3.

Methodology GIS Databases
-Sac Bio datastets (15/5/09)

Planning instrument, Native Title, Previous EPA decision or other matter.

Comments

The Permit has been amended to increase the clearing area from 22.65ha to 24.55ha. The assessment against planning instruments and other matters has not changed; the findings from the previous assessment are still relevant and can be found in the Clearing Permit Decision Report CPS 3104/3.

Main Roads Western Australia (MRWA 2012) have advised that they approve the clearing of native vegetation by Broome Port Authority for the reestablishment of underground power proposed along Port Drive East provided that their advice given is followed. MRWA (2012) require Broome Port Authority to consult with the Yawuru Native Title Holders (RNTBC) Aboriginal Corporation to ensure Aboriginal heritage clearances have been addressed appropriately.

A number of Aboriginal Sites of Significance are located within the application area. The applicant will be advised to liaise with the Department of Indigenous Affairs regarding their obligations under the Aboriginal Heritage Act 1972.

No public submissions have been received in relation to this application.

Methodology Reference:
-Main Roads Western Australia (2012)

GIS Databases:
- Aboriginal Sites of Significance

4. References

DEC (2012a) Regional Advice for Clearing Permit Application CPS 3104/4 . Department of Environment and Conservation. Kimberley Region, Western Australia (DEC Ref: A517683).

DEC (2012b) Additional Regional Advice for Clearing Permit Application CPS 3104/4 . Department of Environment and Conservation. Kimberley Region, Western Australia (DEC Ref: A532025).

Government of Western Australia (2011); 2011 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). WA Department of Environment and Conservation, Perth.

Keighery, B.J. (1994) Bushland Plant Survey: A Guide to Plant Community Survey for the Community. Wildflower Society of WA (Inc). Nedlands, Western Australia.

MRWA (2012) Clearing of Native Vegetation within Main Roads Reserve Port Drive West, Boome Western Australia. (DEC Ref: A468944)

Shepherd, D.P., Beeston, G.R., and Hopkins, A.J.M. (2001), Native Vegetation in Western Australia. Technical Report 249. Department of Agriculture Western Australia, South Perth.

5. Glossary

Term	Meaning
BCS	Biodiversity Coordination Section of DEC
CALM	Department of Conservation and Land Management (now BCS)
DAFWA	Department of Agriculture and Food
DEC	Department of Environment and Conservation
DEP	Department of Environmental Protection (now DEC)
DoE	Department of Environment
DoIR	Department of Industry and Resources
DRF	Declared Rare Flora
EPP	Environmental Protection Policy
GIS	Geographical Information System
ha	Hectare (10,000 square metres)
TEC	Threatened Ecological Community
WRC	Water and Rivers Commission (now DEC)

Attachment D

Coffey (2013) Environmental Advice – Port Drive West

14 June 2013

Broome Port Authority
PO Box 46
Broome WA 6725

Attention: Sean Mulhall

Dear Sean,

RE: Environmental Advice – Port Drive West

This letter has been prepared to provide environmental advice to the Broome Port Authority on the Port Drive West site walkover undertaken by Clinton van den Bergh, a qualified and experienced botanist with Coffey Environments. Advice on Port Drive East was provided by separate correspondence (correspondence dated 30 April 2013).

1 Introduction

Coffey Environments was commissioned by the Broome Port Authority (BrPA) to undertake a site investigation of the Port Drive West development, located on the western side of Port Drive in Broome, to identify any botanical constraints within the area approved to be cleared under Native Vegetation Clearing Permit CPS 3104/2. A copy of CPS 3104/2 is attached as Attachment A.

More specifically, Coffey Environments' botanist searched for the presence of the Threatened Ecological Community (TEC) Monsoon Thickets and the Priority Ecological Community (PEC) Mangarr community on relict dune systems on the Broome Peninsula. In addition to the TEC and PEC searches, the site walkover included searches for the threatened Keraudrenia exastia (T), which is known to occur in close proximity to the site, and introduced weeds.

1.1 Scope

The scope of works for the environmental site investigation of the area within the CPS 3104/2 included:

- A site traverse to record the presence of the TEC Monsoon Thickets.

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PO Box 4223 Victoria Park WA 6979 Australia
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coffey.com

- A site traverse to record the presence of Mangarr (*Sersalisia sericea*) plants, which are the keystone species for the Mangarr community PEC.
- A site traverse to record the presence of the threatened flora, *Keraudrenia exastia* (T).
- A site traverse to record the weed species located within the site.

2 Methodology

The methodology employed for the environmental site investigation included a site traverse to record the presence or absence of the TEC, PEC, *Keraudrenia exastia* (T) and introduced species. A botanist, Mr Clinton van den Bergh, from Coffey Environments, undertook the site traverse on 29 April 2013. Transects, approximately 30 to 50 m (metres) apart, were walked across the site (Figure 1; Attachment B). In addition to the Port Drive West site, the Bush Tucker Park (located adjacent to the site on the eastern boundary and outside the area covered under CPS 3104/2) was traversed to record the number of Mangarr plants present.

The location of any TEC, PEC, DRF or introduced weeds present was identified with a Global Positioning System (GPS), and appropriate details (i.e. condition, size, species composition) recorded.

3 Results

3.1 Threatened Ecological Communities

The TEC Monsoon Vine Thicket was not recorded from Port Drive West. The known location and habitat requirements for the TEC have not previously been recorded from within the Port Drive West site boundary. The TEC is known to occur on the primary and secondary sand dunes of Dampier Peninsula. No significant dune systems (i.e. primary and secondary dunes) were recorded within the site. Photos depicting the vegetation recorded from the site are provided below (Plates 1 and 2).

Plate 1: Open mixed woodland over shrubland dominated by *Acacia colei* var. *colei* over grassland dominated by *Triodia* spp. on orange/red pindan soils

Plate 2: Open mixed woodland over shrubland dominated by *Acacia colei* var. *colei* over grassland dominated by *Triodia* spp. on orange/red pindan soils

NB: The vegetation descriptions have been adapted from Woodman (2008).

3.2 Priority Ecological Communities

Forty-six individual Mangarr (*Sersalisia sericea*) trees were recorded from the Port Drive West and Bush Tucker Park site boundaries (Plates 3 and 4). Fifteen were located within the Port Drive West

boundary, while the remaining 31 were located within the Bush Tucker Park. The GPS details are provided in Table 1, while the locations are mapped on Figure 1.

The site traverse was restricted to searching for the presence of Mangarr plants which may not necessarily suggest the presence of the PEC. However, considering the Mangarr is the keystone species for the PEC and the community has previously been mapped from the Broome Peninsula 600 m to the north-west of the current localities, it can be assumed with high confidence that the PEC occurs in association with the Mangarr plants recorded from the Bush Tucker Park and Port Drive West.

The Mangarr community was listed as a Priority 1 PEC in April 2012. Priority 1 ecological communities are considered to be poorly-known ecological communities. Priority 1 ecological communities are known from very few occurrences with a very restricted distribution (generally equal to or less than five occurrences or a total area of equal to less than 100 ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. This may include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range (definitions obtained from the DEC described in December 2010).

The BrPA was granted a Native Vegetation Clearing Permit approval under Section 51E of the Environmental Protection Act 1986 on 24 October 2009 from the Department of Environment and Conservation (CPS 3104/2). Coffey Environments understands that the presence of a PEC does not constitute grounds for the revocation or suspension of a clearing permit. Section 51L of the *Environmental Protection Act 1986* (EP Act) outlines the grounds for the suspension or revocation of a NVCP being:

a) The Chief Executive Officer (CEO) of the DEC is satisfied that there has been a breach of any of the conditions to where the clearing permit is subject; or

b) Where a person has become the holder of the clearing permit by operation of section 51N, the CEO is satisfied that the person is unwilling or unable to comply with the conditions to which the permit is subject; or

c) Information contained in or supporting the application was false or misleading in a material respect; or

d) The holder of the clearing permit has applied to the CEO to surrender the permit.

However, under Section 51K of the EP Act the CEO of the DEC has the power to amend a NVCP by removing or varying a condition of the permit, or redescribing the boundaries of the land to which the NVCP condition applies. The CEO also has the authority to amend the clearing permit in conformity with an approved policy.

The BrPA should obtain legal advice in relation to its rights and obligations under the conditions of its native vegetation clearing approval (CPS 3104/2) with respect to the Mangarr trees.

Plate 3: Mangarr (*Sersalisia sericea*) tree

Plate 4: Mangarr (*Sersalisia sericea*) tree

Table 1 Mangarr Localities

Location (Code)	Zone	Easting	Northing	Location (Code)	Zone	Easting	Northing
Bush Tucker Park (256)	51	415574	8010130	Bush Tucker Park (289)	51	415570	8010023
Bush Tucker Park (262)	51	415548	8010100	Bush Tucker Park (290)	51	415565	8010022
Bush Tucker Park (263)	51	415553	8010101	Bush Tucker Park (291)	51	415565	8010026
Bush Tucker Park (264)	51	415558	8010105	Bush Tucker Park (292)	51	415568	8010028
Bush Tucker Park (265)	51	415558	8010101	Bush Tucker Park (293)	51	415581	8010048
Bush Tucker Park (266)	51	415566	8010096	Bush Tucker Park (294)	51	415577	8010057
Port Drive West (271)	51	415505	8010049	Bush Tucker Park (295)	51	415564	8010058
Port Drive West (272)	51	415508	8010053	Bush Tucker Park (296)	51	415563	8010060
Port Drive West (273)	51	415520	8010067	Bush Tucker Park (297)	51	415560	8010057
Port Drive West (274)	51	415521	8010043	Bush Tucker Park (298)	51	415557	8010059
Port Drive West (275)	51	415520	8010042	Bush Tucker Park (299)	51	415558	8010062
Port Drive West (276)	51	415523	8010036	Bush Tucker Park (300)	51	415562	8010062
Port Drive West (277)	51	415517	8010033	Bush Tucker Park (301)	51	415583	8010093
Port Drive West (278)	51	415516	8010030	Bush Tucker Park (302)	51	415582	8010094
Port Drive West (279)	51	415510	8010030	Bush Tucker Park (303)	51	415579	8010093
Port Drive West (280)	51	415510	8010034	Bush Tucker Park (304)	51	415584	8010104
Port Drive West (281)	51	415510	8010036	Bush Tucker Park (305)	51	415601	8010094
Port Drive West (282)	51	415507	8010034	Bush Tucker Park (306)	51	415602	8010099
Port Drive West (283)	51	415506	8010039	Bush Tucker Park (307)	51	415615	8010102
Port Drive West (284)	51	415495	8010041	Bush Tucker Park (308)	51	415639	8010141
Port Drive West (285)	51	415484	8009975	Bush Tucker Park (309)	51	415605	8010137
Bush Tucker Park (287)	51	415584	8010022	Bush Tucker Park (310)	51	415609	8010127
Bush Tucker Park (288)	51	415581	8010019	Bush Tucker Park (311)	51	415584	8010109

See Figure 1 for a map showing the locations of the Mangarr plants.

3.3 Keraudrenia exastia

The threatened *Keraudrenia exastia* was not recorded from within the Port Drive West site. *Keraudrenia exastia* has previously been recorded to the south of the site (Woodman, 2008). A 50 m buffer has been applied to the known locations to provide protection from proposed port activities and developments.

3.4 Introduced Weeds

No Declared Plants listed under the Biosecurity and Agriculture Management Act 2007, administered by the Department of Agriculture and Foods Western Australia, were recorded from within the site boundaries.

The introduced taxa, **Passiflora foetida* or Stinking Passion Flower was recorded from several locations throughout the Port Drive West site. The presence of the introduced taxa has previously been recorded by Woodman (2008). The locations of the Stinking Passion Flower are provided on Figure 1 while the GPS details are presented in Table 2 below. It is possible that additional weed species are located within the site boundaries, however, their presence is not considered to pose a significant constraint to the clearing and development of the site.

Table 2 Stinking Passion Flower Locations

Code[1]	Zone	Easting	Northing
257	51	415382	8010140
258	51	415353	8010221
259	51	415321	8010227
260	51	414903	8010239
261	51	415608	8010223
267	51	415533	8010104
268	51	415329	8010105
269	51	415300	8010096
270	51	414996	8010068
286	51	415187	0809948

1 – See Figure 1 for the locations of each Stinking Passion Flower code

4 Conclusions

The majority of the Port Drive West site was traversed on foot by a qualified and experienced botanist. The site traverse involved walking transect lines approximately 30 to 50 m apart (Figure 1).

Based on the results of the environmental site investigation, the TEC Monsoon Vine Thickets and the threatened *Keraudrenia exastia* do not occur within the Port Drive West site boundaries.

Fifteen Mangarr plants were recorded as occurring within the Port Drive West site boundaries. The plants were located near the eastern boundary next to the Bush Tucker Park. An additional 31 Mangarr plants were recorded in the Bush Tucker Park, and are likely to represent the Mangarr PEC (P1).

One introduced flora, **Passiflora foetida*, was recorded as occurring at 10 locations within the Port Drive West site. The majority of the records were located near previously disturbed areas (i.e. road verges), however several records were from the central portion of the site.

If you would like to discuss the results of the environmental site investigation of Port Drive West, please do not hesitate to contact the undersigned on +61 8 9355 7100.

For and on behalf of Coffey Environments Australia Pty Ltd

Clinton van den Bergh
Senior Environmental Scientist/ Botanist

Martine Scheltema
Principal Environmental Consultant

Attachment A: Clearing Permit CPS 3104/2

Attachment B: Figure 1

GOVERNMENT OF
WESTERN AUSTRALIA

CLEARING PERMIT

Granted under section 51E of the Environmental Protection Act 1986

Purpose Permit number:	CPS 3104/2
Permit Holder:	Broome Port Authority
Duration of Permit:	24 October 2009 – 24 October 2014

The Permit Holder is authorised to clear native vegetation subject to the following conditions of this Permit.

PART I – CLEARING AUTHORISED

1. **Purpose for which clearing may be done**
   Clearing for the purpose of commercial development and relocation of utilities corridor.

2. **Land on which clearing is to be done**
   LOT 616 ON PLAN 240107 (PORT MINYIRR 6725)
   LOT 1221 ON PLAN 182648 (PORT MINYIRR 6725)

3. **Area of Clearing**
   The Permit Holder must not clear more than 22.6 hectares of native vegetation within the area hatched yellow on attached Plan 3104/2.

4. **Application**
   This Permit allows the Permit Holder to authorise persons, including employees, contractors and agents of the Permit Holder, to clear native vegetation for the purposes of this Permit subject to compliance with the conditions of this Permit and approval from the Permit Holder.

5. **Compliance with Assessment Sequence and Management Procedures**
   Prior to clearing any native vegetation under conditions 1, 2 and 3 of this Permit, the Permit Holder must comply with the Assessment Sequence and the Management Procedures set out in Part II of this Permit.

PART II – ASSESSMENT SEQUENCE AND MANAGEMENT PROCEDURES

6. **Avoid, minimise etc clearing**
   In determining the amount of native vegetation to be cleared authorised under this Permit, the Permit Holder must have regard to the following principles, set out in order of preference:
   (a) avoid the clearing of native vegetation;
   (b) minimise the amount of native vegetation to be cleared; and
   (c) reduce the impact of clearing on any environmental value.

PART III - RECORD KEEPING AND REPORTING

7. **Records must be kept**
   (a) The Permit Holder must maintain the following records for activities done pursuant to this Permit in relation to the clearing of native vegetation authorised under this Permit:
      (i) the species composition, structure and density of the cleared area;
      (ii) the location where the clearing occurred, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings;
      (iii) the date that the area was cleared; and
      (iv) the size of the area cleared (in hectares).

8. **Reporting**
   (a) The Permit Holder must provide to the CEO, on or before 30 June of each year, a written report of records required under condition 7 of this Permit and activities done by the Permit Holder under this Permit between 1 January and 31 December of the preceding year.

   (b) Prior to 24 June 2014, the Permit Holder must provide to the CEO a written report of records required under condition 7 of this Permit where these records have not already been provided under condition 8(a) of this Permit.

Keith Claymore
A/ DIRECTOR
NATURE CONSERVATION DIVISION

Officer delegated under Section 20
of the Environmental Protection Act 1986

7 January 2010

Plan 3104/2

LEGEND

Clearing Instruments
- Areas Approved to Clear

Road Centrelines
- Cadastre

Cadastre for labelling

Broome - Willie Creek 40cm Orthomosaic - Landgate 2003

N

0 300 m

Scale 1:12260
(Approximate when reproduced at A4)

Geocentric Datum Australia 1994

Note: the data in this map have not been projected. This may result in geometric distortion or measurement inaccuracies.

K Claymore Date 7/1/10

Officer with delegated authority under Section 20 of the Environmental Protection Act 1986

Information derived from this map should be confirmed with the data custodian acknowledged by the agency acronym in the legend.

Department of Environment and Conservation

Our environment, our future

* Project Data is denoted by asterisk. This data has not been quality assured. Please contact map author for details.

Department of Environment and Conservation

Our environment, our future

Clearing Permit Decision Report

1. Application details

1.1. Permit application details

Permit application No.: 3104/2

Permit type: Purpose Permit

1.2. Proponent details

Proponent's name: Broome Port Authority

1.3. Property details

Property: LOT 616 ON PLAN 240107 (House No. 286 PORT MINYIRR 6725)
LOT 616 ON PLAN 240107 (House No. 286 PORT MINYIRR 6725)
LOT 616 ON PLAN 240107 (House No. 286 PORT MINYIRR 6725)
LOT 1221 ON PLAN 182648 (House No. 288 PORT MINYIRR 6725)

Local Government Area:

Colloquial name:

..4. Application

Clearing Area (ha)	No. Trees	Method of Clearing	For the purpose of:
22.6		Mechanical Removal	Building or Structure

2. Site Information

2.1. Existing environment and information

2.1.1. Description of the native vegetation under application

Vegetation Description	Clearing Description	Vegetation Condition	Comment
Beard Vegetation Association 750: Shrublands, pindan; Acacia tumida shrubland with grey box & cabbage gum medium woodland over ribbon grass & curly spinifex (Shepherd, 2007)	The application is for the clearing of 22.6 (was 21.13 ha) of native vegetation for commercial purposes. The vegetation under assessment is classified as being in good to degraded (Keighery, 1994) condition. The vegetation type is open Pindan wattle consisting of Eucalyptus and Acacia species (DEC, 2009a).	Good: Structure significantly altered by multiple disturbance; retains basic structure/ability to regenerate (Keighery 1994)	The vegetation condition was assessed through aerial photography (Broome - Willie Creek 40cm Orthomosaic - Landgate), a site inspection (DEC, 2009a), and survey (Coffey, 2009).

3. Assessment of application against clearing principles

(a) Native vegetation should not be cleared if it comprises a high level of biological diversity.

Comments

Proposal may be at variance to this Principle

The application is for the clearing of 22.6ha (amended from 21.13 hectares) of native vegetation for commercial purposes and relocation of utilities corridor. The vegetation within the application area is considered to be in a good to degraded (Keighery, 1994) condition. The vegetation type is open Pindan wattle consisting of Eucalyptus and Acacia species (DEC, 2009a).

The area under application is located within the Port of Broome industrial precinct in an area already highly developed. It consists of rare and priority flora species known only from a few populations including 'Keraudrenia exastia which is currently ranked critically endangered' (DEC, 2009b). The applicant has ensured that a 50m buffer is maintained from K exastia and 'environmental planning and management measures will be implemented to minimise potential secondary impacts, e.g. hydrological' (Coffey, 2009b). This species has been survey thoroughly throughout the application area.

Although the Broome peninsula has approximately 65% native vegetation remaining (60% after the proposed clearing), the application area is located near the southern tip of the peninsula and the clearing as proposed would break the vegetation connectivity running south to north along the western and central section of the lower end of the Broome Peninsula and remove important flora and fauna habitats and dispersal capabilities.

There is currently an active clearing permit on Port Drive (CPS1417/1) for the applicant. A section of CPS3104/1 is located adjacent to this permit on the eastern side of Port Drive. Clearing in this area would lead

to a significant reduction in vegetation on both sides of the road.

Given the above the proposal may be at variance to this principle.

Methodology
Coffey (2009b)
DEC (2009a)
DEC (2009b)
Keighery (1994)
GIS Layer:
- Broome 1m Orthomosaic - DOLA 00

(b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

Comments

Proposal may be at variance to this Principle

The clearing as proposed may impact fauna movements throughout the peninsula, given it cuts through the western and central area of the peninsula which is well vegetated. A small strip of vegetation will remain after clearing on the eastern side of the Broome Peninsula running north to south. Given the proximity to the clearing and the coast line, the remaining vegetation is likely to be easily disturbed (edge effects).

The application area is likely to contain some large hollow-baring trees and be a significant habitat for fauna in the region. Such habitat provides value for hollow roosting species such as bats, some birds, pythons and arboreal mammals (Coffey, 2009a).

There are nine known records of fauna species of conservation significance within the local area (10km radius). They are:
- Burhinus grallarius (Bush Stonecurlew) - P4
- Wyulda squamicaudata (Scaly-tailed Possum) - P3
- Hydromys chrosogaster (Water rat) - P4
- Ixobrychus flavicollis australis (Peregrine Falcon) - Other specially protected species
- Falco hypoleucos (Grey Falcon) - P4
- Numenius madagascariensis (Eastern Curlew) - P4
- Polytelis axandrae (Princess Parrot) - P4
- Macrotis lagotis (Bilby) - Vu

The Peregrine Falcon and Bush Stonecurlew are likely to be found within the application area (Woodman, 2008). Clearing is likely to lead to the loss of foraging habitat for the Peregrine Falcon and disturbance and loss of habitat for the Bush Stonecurlew (Woodman, 2008). Pindan vegetation that occurs within the application area is widespread across the peninsula and bioregion and given this, may not be significant habitat for the Falcon and Stonecurlew (Coffey, 2009b).

Although the type of vegetation to be cleared is not preferred habitat for the majority of the above priority species, it may provide an ecological linkage to facilitate fauna (such as wallabies and lizards) (DEC, 2009) movement throughout the Peninsula.

Given the above, the proposal may be at variance to this principle.

Methodology
Coffey (2009a)
Coffey (2009b)
Woodman (2008)
GIS Layer:
- Sac Biodatasets 150509

(c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.

Comments

Proposal may be at variance to this Principle

There is one known record of rare flora within the local area of the proposed clearing site. Populations of Keraudrenia exastia (Critically Endangered) have been recorded on the DEC database as close as 50m south and 20m north of the application area. It is found on the same vegetation (750) and soil type (AB21) as the application area.

A survey of the application area and it surrounds found numerous plants of K. exastia growing within the local area (DEC, 2009a, Coffey, 2009a). K. exastia is known to grow in the 'swale between dunes in red clays-sand with slow soil drainage' (DEC 2009b). The applicant has ensured that a 50m buffer is maintained from K exastia and 'environmental planning and management measures will be implemented to minimise potential secondary impacts, e.g. hydrological' (Coffey, 2009b, DEC 2009b). This species has been surveyed thoroughly throughout the application area.

In addition a Scleria sp., which is potentially a new species, was found within the application area (Coffey, 2009). The clearing as proposed will impact on '107 individual plants or 40% of the total known population of Scleria sp.'(Coffey, 2009). A further survey on Scleria sp. has identified that the species is more wide spread than first thought with the proposed clearing only impacting on 4.1% of the Scleria population (Coffey, 2009b).

It is recommended that taxonomic work is undertaken to determine Scleria sp. true identity so its conservation status can be confirmed and a representative of each Scleria sp. population be submitted to the WA Herbarium' (DEC, 2009b).

There are five known records of priority flora within the local area (10km radius) that fall within the same vegetation and soil type of the proposed clearing area. Two were located within a Broome Peninsula survey but not within the application area (Coffey, 2009). They are:
- Phyllanthus aridus (P3)
- Goodenia byrnesii (P1)

Given the above the proposal may be at variance to this principle.

Methodology Coffey (2009a)
Coffey (2009b)
DEC (2009b)
Sac Biodatasets 150509

(d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.

omments **Proposal is not likely to be at variance to this Principle**
There are two records of threatened ecological communities within the local area of the proposed clearing area. They are:
- Roebuck Bay mudflats (faunal mudflat community) - 3.1km northwest of the application area. The application area is outside the boundary but within the buffer of this TEC but in different vegetation type. The application area is separated from the community by infrastructure and 'potential secondary impacts caused by hydrological, dust or ecological changes are considered to be negligible given the intertidal nature and large extent of the ecosystem (Coffey, 2009b).
- Vine Thickets - 4.8kms and 9.5kms north of the application area. The Vine thickets are located in the shelter of sand dunes, inland from Cable Beach and extending south to Gantheaume Point. The thickets represent the southernmost stand of rainforest in the Kimberley, are important seasonal food sources, and are of high ecological importance (Burbidge et al., 1991). The proposed clearing does not fall within the boundary or buffer of the TEC.

One priority ecological community (PEC), Dwarf Pindan Heath is located 2.6km northwest of the application area, the proposed clearing falls outside the boundary but within the buffer of this PEC. Given the characteristics of this PEC (wind-pruned shrubs and spinifex grasslands on coast cliffs near linear dunes) differs vastly from the vegetation within the application area and the large distance between the PEC and application area, it is not likely that clearing will impact on this PEC.

Given the above, the proposal is not likely to be at variance to this principle.

Methodology Burbidge et al., (1991)
Coffey (2009b)
GIS Layer:
- Sac Biodatasets 150509

(e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

Comments **Proposal is not likely to be at variance to this Principle**

	Pre-European (ha)	Current extent (ha)	Remaining (%)	% In reserves DEC Managed Land
IBRA Bioregions*				
Dampierland	8,345,180	8,316,459	99.66	1.06
Shire*				
Broome	5,469,435	5,430,728	99.29	0.88
Beard Vegetation Association*				
750	1,229,176	1,227,005	99.82	2.27

Beard Vegetation Association with Bioregion*				
750	1,229,176	1,227,005	99.82	2.27

* (Shepherd et al. 2007)

The area applied to clear is a component of Beard Vegetation Association 750 which as 99.82% of the pre-European extent remaining (Shepherd, 2007). The vegetation within the application area is considered to be in a good to degraded (Keighery, 1994) condition.

Clearing of 22.6 hectares of vegetation will not significantly reduce the remaining extent of this broader Association and therefore the proposal is not likely to be at variance to this principle.

Methodology Shepherd (2007)

(f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

Comments **Proposal is not likely to be at variance to this Principle**
The Western Australian coastline is located 95m east and Roebuck Bay Mangrove to Watercourse 4.5km north east of the application area.

Given the distance to the closest watercourse and wetland from the application area it is unlikely that the proposal is at variance to this principle.

Methodology GIS Layer:
- Hydrography, linear (hierarchy) - DOE 13/4/05
- RAMSAR, Wetlands - CALM 14/02/03
- ANCA, Wetlands - CALM 08/01

(g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

Comments **Proposal is not likely to be at variance to this Principle**
The soils on site are chiefly red earthy sands (Northcote et al., 1960-68) so have a moderate potential for erosion (Schoknecht, 2002).

The area proposed for development has been somewhat disturbed by surrounding development and track creation. The elevation and topography of the area are relatively flat gently sloping downwards towards the north. The topography and erosion potential of the soils on site suggest that there is a risk of wind erosion, however this would not be significant if the vegetation from this site were to be removed during the dry season.

The proposal is not likely to be at variance to this principle.

Methodology (Northecote et al., 1960-68)
(Schoknecht, 2002)

(h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

Comments **Proposal is not likely to be at variance to this Principle**
There are 3 records of conservation reserves within the local area (10km radius). These are Conservation Commission Office and Nursery (3.9km NE); Conservation Commission Wildlife Rehabilitation (9.1km NE); and Roebuck Bay Mangrove to watercourse (ANCA wetland 4.5km NE).

Given the distance between the conservation reserves and the application area it is unlikely that the proposal as stated will be at variance to this principle.

Methodology GIS Layer:
- CALM Managed Lands and Waters - CALM 1/07/05
- Broome 1m Orthomosaic - DOLA 00

(i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

Comments **Proposal is not likely to be at variance to this Principle**
The proposal area is located in the Broome Townsite Sub-areas within the Broome Groundwater Area proclaimed under the Rights in Water and Irrigation Act 1914. Dampier Creek lies approximately 7 kilometres north east of the proposal area. The Public Drinking Water Source Protection Area, consisting of P1 and P3 protection zones, lies approximately 15 kilometres north of the site.

Due to the distance away from the creek, coast and Public Drinking Water Source Protection Area, it is unlikely that the clearing will cause deterioration in the quality of surface or underground water.

Methodology GIS Layer:
- Public Drinking Water Source Areas (PDWSAs) - DOE 07/02/06
- RIWI Act, Surface Water Areas - WRC 18/10/02
- RIWI Act, Groundwater Areas - WRC 13/06/00
- Hydrography, linear (hierarchy) - DOE 13/4/05

(j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

Comments **Proposal is not likely to be at variance to this Principle**
Flooding occurs seasonally over the December to March period, where the flood height and duration are lengthy and extreme. Soils within the application area are red earthy sands (Northcote et al., 1960-68).

It is unlikely that the clearing of 22.6 hectares of native vegetation will lead to an incrementally increase in peak flood height and flood peak.

Methodology Northcote et al. (1960-68)

Planning Instrument, Native Title, Previous EPA decision or other matter.

Comments

The application is for the clearing of 22.6ha (amended from 21.13 hectares) of native vegetation for commercial purposes and relocation of utilities corridor.

The applicant forwarded a submission (Coffey, 2009b) to Department of Environment and Conservation letter dated 25 June 2009. Where applicable advice on environmental issues have been addressed within the clearing principles.

Rezoning of application area is not required from the Shire of Broome (DEC TRIM Ref: DOC98525). Site is to be subdivided and leased for commercial purposes. Planning approval and business licences will be required from tenants.

The Shire of Broome has no objections with the clearing of native vegetation for commercial purposes (DEC TRIM Ref: DOC86177).

Methodology Coffey (2009b)
(DEC TRIM Ref: DOC86177)

4. Assessor's comments

Comment

The application has been assessed against the clearing principles, planning instruments and other matters in accordance with s51O of the ıvironmental Protection Act 1986, and the proposed clearing may be at variance to Principle (a), (b) and (c) and is not likely to be at variance .ɔ the remaining clearing Principles.

5. References

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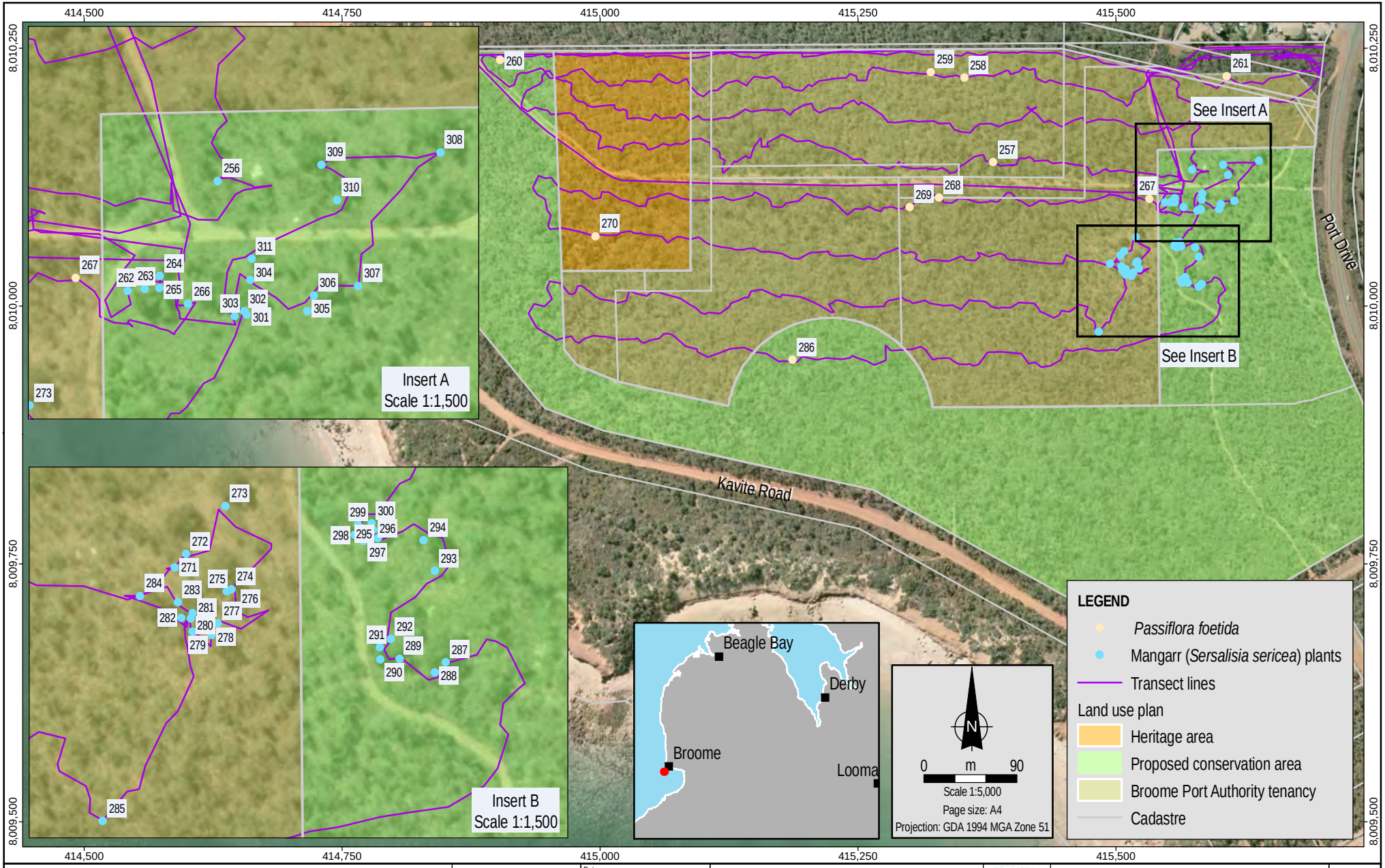
Schoknecht N. (2002) Soil Groups of Western Australia. A simple guide to the main soils of Western Australia. Resource Management Technical Report 246. Edition 3

Shepherd, D.P. (2007). Adapted from: Shepherd, D.P., Beeston, G.R., and Hopkins, A.J.M. (2001), Native Vegetation in Western Australia. Technical Report 249. Department of Agriculture Western Australia, South Perth. Includes subsequent updates for 2006 from Vegetation Extent dataset ANZWA1050000124.

Woodmans (2008). Fauna Assessment of the Broome Port. Woodman Environmental Consulting Pty Ltd. 31st July 2008.

6. Glossary

Term	Meaning
BCS	Biodiversity Coordination Section of DEC
CALM	Department of Conservation and Land Management (now BCS)
DAFWA	Department of Agriculture and Food
DEC	Department of Environment and Conservation
DEP	Department of Environmental Protection (now DEC)
DoE	Department of Environment (now DEC)
DMP	Department of Mines and Petroleum (ex DoIR)
DRF	Declared Rare Flora
EPP	Environmental Protection Policy
GIS	Geographical Information System
ha	Hectare (10,000 square metres)
TEC	Threatened Ecological Community
WRC	Water and Rivers Commission (now DEC)



Source & notes:
Passiflora foetida and Mangarr (Sersalisia sericea) plants locations from Coffey (April 2013).
Indicative land use areas (August 2008) and lease premises (February 2012) from Survey North.
Aerial imagery from Broome Port Authority.

coffey environments

Date: 29.05.2013
MXD: 3627_01_GIS001_v0_2
File Name: 3627_01_F001_GIS

Broome Port Authority

Environmental Advice

Environmental Advice

Figure No: **1**

Attachment E

Coffey (2013) Environmental Site Investigation – Port Drive East

coffey environments
SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE

30 April 2013

Broome Port Authority
PO Box 46
Broome WA 6725

Attention: Sean Mulhall

Dear Sean,

RE: Environmental Site Investigation, Port Drive East

Coffey Environments was commissioned by the Broome Port Authority (BrPA) to undertake a site investigation of the Port Drive East development, located in the eastern side of Port Drive in Broome. More specifically, Coffey Environments' botanist searched for the presence of the Threatened Ecological Community (TEC) Monsoon Thickets and the Priority Ecological Community (PEC) Mangarr community on relict dune systems on the Broome Peninsula. The remainder of this letter details the scope, methodology and results of the environmental site investigation.

Scope

The scope of works for the environmental site investigation included:

- A site traverse to record the presence of the TEC Monsoon Thickets.
- A site traverse to record the presence of Mangarr (*Sersalisia sericea*) plants, which are the keystone species for the Mangarr community PEC.
- A site traverse to record the presence of the threatened flora, *Keraudrenia exastia* (DRF).
- A site traverse to record the weed species located within the site.
- The preparation of a brief letter detailing the results of the environmental site investigation.

Methodology

The methodology employed for the environmental site investigation included a site traverse to record the presence or absence of the TEC, PEC, *Keraudrenia exastia* and introduced species. A botanist,

Mr Clinton van den Bergh, and an ecologist, Dr Paul Mitrovski, both from Coffey Environments, undertook the site traverse on 29 April 2013. Transects, approximately 10 to 20 m (metres) apart, were walked across the site, including additional areas to the north and east of the site boundary (Figure 1).

The location of any TEC, PEC, DRF or introduced weeds present was recorded with a Global Positioning System (GPS) and essential details recorded (i.e. condition, size, species composition).

Results

The TEC Monsoon Thickets was not recorded from within the site boundaries.

A known location, as mapped by the Department of Environment and Conservation (DEC), of the TEC is located immediately to the north of the site. The TEC is not expected to occur within the site due to the habitat requirements of the TEC. The TEC is located on the primary and secondary sand dunes of Dampier Peninsula. No significant dune systems (i.e. primary and secondary dunes) were recorded within the site. Photos depicting the vegetation recorded from the site are located below (Plates 1 to 4).

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Plate 1
Open mixed woodland over shrubland dominated by Acacia colei var. colei over grassland dominated by Triodia spp. on orange/red pindan soils</td><td>Plate 2:
Open mixed woodland over shrubland dominated by Acacia colei var. colei over grassland dominated by Triodia spp. on orange/red pindan soils</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Plate 3
Open mixed woodland over shrubland dominated by Acacia colei var. colei over grassland dominated by Triodia spp. on orange/red pindan soils</td><td>Plate 4
Open mixed woodland over shrubland dominated by Acacia colei var. colei over grassland dominated by Triodia spp. on orange/red pindan soils</td></tr>
</table>

NB: The vegetation descriptions have been adapted from Woodman (2008).

The PEC Mangarr community was not recorded from within the site boundaries. No Mangarr (*Sersalisia sericea*) plants were recorded from within the site boundaries. The Mangarr is the key component of the PEC and therefore its absence suggests the PEC does not occur within the site boundaries.

The threatened flora *Keraudrenia exastia* does not occur within the site boundaries. It is known to occur to the west of Port Drive East and has not previously been recorded from within the site boundaries.

Two introduced species, **Cenchrus ciliaris* and **Passiflora foetida,* were recorded from within the site boundaries. Both species were recorded in association with previously disturbed areas, for example the road verge and the southern section in association with an old informal track. Both species are considered to be widespread in the Broome region and are currently not listed as Declared Plants under the *Agriculture and Related Resources Protection Act 1976*. However, **Cenchrus ciliaris* and **Passiflora foetida* are considered to be environmental weeds with a high category rating due to their invasiveness, current and potential distribution and the impact to the environment (CALM, 1999).

Conclusion

Based on the results of the environmental site investigation, the TEC Monsoon Thickets, the PEC Mangarr community and the threatened *Keraudrenia exastia* do not occur within the site boundaries. Therefore proposed geotechnical drilling and the subsequent clearing of vegetation will not directly impact the significant vegetation and flora species.

Two introduced flora species (**Cenchrus ciliaris* and **Passiflora foetida*) were recorded as occurring within the site boundaries. The introduced species were recorded in the south of the site in association with previously disturbed areas and road verges. See Attachment A for GPS coordinates

If you would like to discuss the results of the environmental site investigation further, please do not hesitate to contact the undersigned on 08 9355 7100.

For and on behalf of Coffey Environments Australia Pty Ltd

Clinton van den Bergh
Senior Environmental Scientist (Botany)

Martine Scheltema
Principal Environmental Consultant

Attachments

A GPS Coordinates for Introduced Flora Species

References

Department of Conservation and Land Management (CALM).1999. Environmental weed strategy for Western Australia including Weedbase [a database of environmental weeds of Western Australia].

Woodman Environmental Consulting Pty Ltd (Woodman). 2008. Broome Port Authority – Floristic Community Types of the Broome Peninsula. Unpublished Report prepared for the Broome Port Authority, October 2008.

Figure 1: GPS Tracks from Site Traverse

NB: The blue lines represent the tracks recorded from the GPS, while the pink lines represent the cadastral boundaries.

Attachment A

GPS Coordinates for Introduced Flora Species

Species	GDA94; Zone 51	
	Easting (mE)	Northing (mN)
Cenchrus ciliaris	415972	8009662
Cenchrus ciliaris	415978	8009648
Cenchrus ciliaris	416089	8009488
Passiflora foetida	416056	8009432

Attachment F

Woodman (2008) Flora Assessment

BROOME PORT AUTHORITY

FLORISTIC COMMUNITY TYPES OF THE BROOME PENINSULA

May 2008

woodmanenvironmentalconsulting

A.C.N. 088 055 903

DOCUMENT REVISION HISTORY

Revision	Description	Originator	Reviewed	Date
A	Draft Report to Client	CG/KG	GW	21-05-08
0	Final Report	CG/KG	GW/ Capt. Vic Justice	30-05-08

WEC REF: POB07-21-01

DISCLAIMER

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EXECUTIVE SUMMARY

The Broome Port Authority (BPA) manages the Port of Broome, located approximately 2200 km north north-east of Perth, and is the largest port within the Kimberley Region. Approximately 128.1 ha of land is currently managed by the BPA, situated on the southern extremity of the Broome Peninsula on the south-west side of the township of Broome. The BPA are proposing to expand currently existing laydown areas for off-shore maritime industry support. A total of 30 ha of native vegetation is proposed to be cleared by the BPA as part of this project. Additionally, a further 43.85ha of native vegetation is proposed to be transferred into the Minyirr Park, as an environmental corridor.

Woodman Environmental Consulting Pty Ltd (Woodman Environmental) was commissioned by the BPA to provide a staged flora and vegetation review of the BPA managed lands. The survey area included in this report also included UCL to the north of this area. The main aims of this report were to describe and map the Floristic Community Types (FCTs) of the survey area, and to provide details regarding the impacts of the BPA proposal on the distribution of these FCTs, and known locations of Threatened Ecological Communities (TECs), Declared Rare Flora (DRF) and other conservation significant flora species known from the area.

The original field survey was conducted by Catherine Godden and Bianca Taylor from 27th – 31st August 2007, with a second field survey conducted by Greg Woodman, Bianca Taylor, Kylie Greenacre and Brendan Stratton from 7th – 11th April 2008. Assistance was provided by Mr. Neil McKenzie, an elder of the Yawuru tribe. A series of 31 20m x 20m permanent quadrats were established, from which information regarding height and percentage foliage cover of all alive species was recorded. Statistical analysis using PATN on presence/absence species data was undertaken in the field to determine FCTs present in the survey area. Aerial photography at a scale of 1:10 000 was utilised in conjunction with this data to determine FCT boundaries within the survey area.

A total of two Sub-groups and eight FCTs were determined from the statistical analysis. The two Sub-groups were composed of quadrats located in either coastal sites (sub-group 1) or on pindan soils (Sub-group 2). Three FCTs were identified within each Sub-group.

A total of 167 discrete vascular plant taxa, from 113 genera and 53 families, were recorded during the surveys conducted in August 2007 and April 2008.

Five conservation significant flora species were recorded during the surveys in August 2007 and April 2008. *Keraudrenia exastia*, a DRF taxon, was recorded in one quadrat. This species is known from the survey area, and it's current known distribution is restricted to this area. The plot was located near a known population, however was just outside of this area. Additional searching for this species found a total population within the Port of Broome managed lands of approximately 21,000 individuals.

Goodenia byrnesii(P1) was recorded in seven of the 31 quadrats established during the survey and also at various locations throughout the survey area. The distribution of this

species is restricted to the Northern Botanical Province, mostly near Broome and to north of Halls Creek (DEC 2008c).

Triodia acutispicula (P3) was also recorded in 17 of 31 quadrats established during this survey. This species is fairly widespread through the Kimberley region, and has previously been recorded by Woodman Environmental from sites to the east of Broome during other surveys. This species should be reviewed with a view to removing it from the Priority Flora list.

Phyllanthus aridus, a Priority 3 species, was recorded in one location in the Broome survey area, with Woodman Environmental Consulting previously recording several locations between Broome and Port Headland in 2007 (Woodman Environmental 2007e).

Scleria sp., a possible new taxon, was recorded in two of the 31 quadrats established. This taxon was also previously recorded by Woodman Environmental during a survey near Stokes Bay earlier in 2007, and requires more extensive survey and collecting in order to determine its taxonomic status.

The vegetation of the project area displayed the effects of long term disturbance associated with proximity to development with introduced species common. However the condition of the vegetation was mainly in Very Good Condition, with the exceptions being the edges of tracks and developed areas where weeds such as Cenchrus ciliaris (Buffel Grass) and Aerva javanica (Kapok) were common.

From this study it can be seen that the floristic groupings respond to a combination of soil type (pindan associations versus coastal dune sand associations), hydrology (dune crest associations versus vine thickets of the dune base) and climate factors (FCT 4 at the exposed southern end of the Peninsula on pindan soils versus FCT 5 on northern sections of the Peninsula on pindan soils).

This study has identified several floristic community types of conservation significance. FCT 3, which is representative of TEC 67 (Monsoon Thickets) is located on the inland side of coastal dunes along the Dampier Peninsula, and tend to become larger and have greater species diversity in a northwards direction. No intact areas of this FCT are located within the Port of Broome managed lands, though areas near the southern tip of the peninsula may have been representative of this FCT in the past prior to the severe disturbance associated with the Port and related activities since settlement.

The PEC 11 Kimberley (*Corymbia paractia* dominated community on dunes) is reportedly common between Gantheaume Point and Cable Beach, however it is apparently restricted to a narrow coastal zone in the Broome area where beach dunes merge into pindan soils (Kenneally *et. al.* 1996), and is often found mixed with rainforest (monsoon) species (Kevin Kenneally and Val English *pers. comm*). This community is likely to be either a subset of the TEC 67 community or to occur as a mosaic within it. This community could not be identified as a separate entity during this study and as such has not been mapped. This community is not located within the Port of Broome managed lands.

PEC 10 Kimberley (Dwarf pindan heath community of Broome coast). This community was described by Trudgen (1988) as 'AtGp' on pindan soils (Table 3), and is a reference to *Acacia tumida* var. *kulpan*, which occurs on coastal cliffs at Gantheaume Point and James Price Point as a wind pruned shrub to 50cm in height (Kevin Kenneally and Val English, *pers. comm*.). This vegetation type is discussed in Broome Botanical Society Inc. (1995), where it is located on the near-coastal hinterland from Gantheaume Point past Riddell Beach towards the Port of Broome. PEC 10's characteristics include low-profile wind-sheared shrubs, small areas of almost monotypic spinifex grasslands and traces of residual Pleistocene linear dunes. This community was mapped as FCT 6 and is not located within the Port of Broome managed lands.

FCT 4 Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions. This FCT is likely to be restricted to the southern end of the Broome Peninsula as it potentially occurs as a result of the unique climate of this area, being surrounded in close proximity on 3 sides by the Indian Ocean and Roebuck Bay. This has also been reported by Malcolm Trudgeon in his survey of the Broome Peninsula. Additional clearing of this FCT within the Port of Broome managed lands should concentrate on areas of degraded vegetation and be offset by areas of this community in Good condition or better being preserved within a reserve system.

The following recommendations are given:

Keraudrenia exastia

- Areas of proposed development should be re-designed to avoid all locations of this species, preferably leaving a buffer of approximately 50m.
- Conditions should be placed on all developments in the vicinity of this species to ensure the plants are protected from direct and indirect impacts such as dust and drainage from industrial sites.
- The populations of this species should be monitored every 3 years.
- The Port of Broome should liaise with the Broome Botanical Society and the Department of Environment and Conservation regarding the preservation of this species with the objective of identifying and funding appropriate research on the ecology and propagation strategies of the species. The results of this research to be used as part of a management/recovery plan for the species on the Broome Peninsula.

Port of Broome Environmental Management Programme

- An Environmental Management Plan (EMP) should be developed to address the on-going management of the Environmental Cultural Corridor and the remaining vegetation of the Port of Broome managed lands. This document should include sections on weed management, fire management, drainage, cultural aspects and monitoring. An outline for this EMP is provided in Appendix L.

1. Introduction

The Broome Port Authority (BPA) manages the Port of Broome, located approximately 2200 km north north-east of Perth, and is the largest port within the Kimberley Region. The Port currently handles a wide range of imports into and exports from Broome and supports many industries, including pearling, offshore oil and gas supply vessels, livestock exports and cruise liners, as well as being the largest fuel and container port for the region. The total length of the jetty was extended to 331m in 2005, to allow a greater volume of imports and exports, and to allow for correct segregation of non-compatible industries (Port of Broome 2008).

Approximately 128.1 ha of land is currently managed by the BPA, situated on the southern extremity of the Broome Peninsula on the south-west side of the township of Broome. The BPA are proposing to expand currently existing laydown areas for off-shore maritime industry support. A previous application to clear 3.3ha of native vegetation was approved in 2006, however advice from the Environmental Protection Authority (EPA) determined that the BPA was to prepare an environmental management plan to address the following issues:

- Protection of declared rare flora and locally significant vegetation
- Consideration of culturally significant vegetation
- Spatial arrangement of agreed environmental cultural corridors (ECCs) and commitments and to manage their on-going maintenance as ECCs;
- Weed management
- Impact of proposed land-use (EPA 2006).

Approximately 30 ha of native vegetation is proposed to be cleared by the BPA as part of this project. Additionally, approximately 43.85ha of native vegetation is proposed to be transferred into the Minyirr Park, as an environmental corridor. The Minyirr Park is situated on coastal country near Cable Beach and Roebuck Bay (Western Australian Planning Commission 2007). A Shire Coastal Management Committee has been established, composed of Rubibi and Shire of Broome representatives, working together with other groups and agencies to protect and promote Aboriginal culture and heritage, maintain the environmental integrity of the coastal areas and provide appropriate recreational activities (WAPC 2007).

Woodman Environmental Consulting Pty Ltd (Woodman Environmental) was commissioned by the BPA to provide the following:

- Field survey for *Keraudrenia exastia* (DRF) and other conservation significant species within the Port of Broome managed/owned lands, as well as in the region;
- Plant community mapping throughout the Port of Broome managed/owned lands, including searching for the known TEC in the area;
- Map location of all significant flora colonies;
- Establish the potential impact of proposed land use within Port Lands and adjacent lands;

- Formulate outline of a management plan for the environmental corridor (including strategies to encourage endangered flora species within the corridor)
- Formulate outline of a weed management plan.

The survey area utilised was located on the Broome Peninsula, extending northwards from the Port area to the south of the Broome township, to Gantheaume Point, extending just north of the airstrip, ending at Cable Beach Road. A small area of intact bushland was also included along the coastline to the south of the township. Only BPA-managed lands, and UCL were included in this survey. Figure 1 presents the survey area of the Broome Peninsula comprising 1400 ha.

1.1 Aims of Current Report

The aims of this report are to:

- Describe and map the Floristic Community Types (FCTs) of the Broome Peninsula (survey area)
- Report on potential impacts of the proposed development to DRF and Priority flora species in the area, as well as FCTs and known Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) known from the area.

2. Background

2.1 Climate

The climate of the Dampierland Region is Dry Hot Tropical, with 7-8 dry months per year (Beard 1990). The vast majority of the average annual rainfall is experienced in the months January – March, with lesser rainfall also experienced in December, and April – June (Table 1). Average maximum temperatures are hot, with little variation between months; the highest average maximum temperature occurs in March with 33.9^{o}C, in comparison with lowest average maximum temperature of 28.8^{o}C in July). There is more variation in the average minimum temperature, ranging between 26.4^{o}C in December, and 13.6^{o}C in July (Table 1).

Table 1: Average Maximum and Minimum Temperatures (^{o}C) and Rainfall (mm) at Broome Airport

Month	Average Max. (^{o}C)	Average Min. (^{o}C)	Rainfall (mm)
Jan	33.3	26.3	175.1
Feb	32.9	26	178.3
Mar	33.9	25.4	103.4
Apr	34.3	22.6	26.9
May	31.5	18.3	27.5
Jun	29.1	15.1	18.7
Jul	28.8	13.6	6
Aug	30.2	14.9	1.8
Sep	31.7	18.4	1.4
Oct	32.8	22.3	1.3
Nov	33.6	25	7.9

Table 1: Average Maximum and Minimum Temperatures (°C) and Rainfall (mm) at Broome Airport			
Month	**Average Max. (°C)**	**Average Min. (°C)**	**Rainfall (mm)**
Dec	33.8	26.4	53.1
Annual	32.2	21.2	599.9

Note: Data for Broome Airport; Temperature data averaged over years 1939 – 2007; Rainfall data averaged over years 1939 – 2008

Note: Data is red reflects the highest maximum and minimum temperatures and highest recorded rainfall; Data in blue reflects the lowest maximum and minimum temperatures and lowest recorded rainfall.

2.2 Geology and Soils

The survey area is situated on the Canning Basin, which contains Phanerozoic rocks laid down upon a Precambrian bassement in various epochs, underlying plains or relatively low hills (Beard 1979). The sedmiments in the Canning Basin have remained largely flat-lying and unfolded, because the area has been relatively tectonically stable (Beard 1979). These Phanerozoic sedimentary basins were created at approximately the end of the Proterozoic time but subsidence of the crust to the southwest of the King Leopold mobile zone. This area has mainly been above sea level since the late Cretaceous period. The Kimberley area as a whole existed as an island separated from the rest of Western Australia by a marine gulf during the Palaeozoic and Mesozoic eras.

In the Canning Basin the earliest sediments are of Ordovician age, and comprise of limestone, dolomite and sandstone. Reef limestones of the Devonian area are known from the Canning Basin. Within the Canning Basin, laterite areas are overlain by sand with sandplains and dunefields occupying nearly all of the Dampier Peninsula and the western Fitzroy Basin, with the dunefields being linear and parallel.

The survey area is located on the Coastal Plains Region of the Dampierland Province of the Fitzroyland Physiographic Division (Beard 1979). The Dampierland Province is comprised of sandplains and dunefields underlain by Jurassic-Cretaceous sequences of conglomerate, sandstone and siltone, with rocks being lateritised in many areas. The majority of the Province is less than 120m above current sea-levels, with slight relief (Beard 1979).

The main soil type of the Dampier Peninsula is the pindan, which developed over the Quaternary period. Red earthy sands predominate, and are formed from coherent clayish sands. There is little or no organised surface drainage, with seasonal runoff forming sheets of water behind the coastal dune systems. A more recent and coarser sand layer is also found around Broome (Kenneally *et. al.* 1996).

2.3 Vegetation

2.3.1 Regional Vegetation Units

The survey area is located within the Dampier Botanical District (Dampierland Region), of the Northern Province (Beard 1990). The Northern Province comprises approximately 12% of the land mass of the state of Western Australia. Most of the Northern Province is covered in grassland vegetation, with tropical savannas dominating the area, and spinifex grasslands

found on the fringes of the desert and on shallow, sandy or rocky soils (Beard 1990). Tropical savannahs usually consist of a tree stratum and grass stratum, however in areas either stratum may not be locally present, with a shrub stratum also sometimes occurring. Usually one or a few species will dominate the biomass of each stratum, with species dominanting tree and grass strata being independent of each other.

The Dampierland Region extends from Eighty Mile Beach in the west to include Derby and Fitzroy Crossing in the east, and is bounded to the south by the Great Sandy Desert. The topography and soils of the Dampier Botanical District are composed of extensive riverine plains with grey and brown cracking clays, extensive sandplains on red earthy sands, low uplands of sandstone and limestone with shallow stony soils (Beard 1990). The area is underlain by a mixture of quaternary sandplain overlying jurassic sandstones; quaternary marine deposits on coastal plains, with devonian reef limestones and extensive alluvial river plains (Beard 1990).

The vegetation of the Dampier Botanical District was described by Beard (1990) as 'Tree savannah of *Chrysopogon-Dichanthium* with scattered *Eucalyptus microtheca* and *Lysiphyllum cunninghamii* on river plains; pindan on sandplains. The latter is a 'three-layered community, an open upper stratum of low trees, a closed middle layer of *Acacia* and an open ground layer of curly spinifex; hummock grassland with scattered trees on uplands'.

Pindan vegetation is characteristic of Dampierland, and occurs on all sandy plains. The pindan is a woody grassland, with a sparse upper layer of trees and a dense middle stratum of *Acacia* species. Fire is a major characteristic of the area, with the ground stratum of grasses and middle stratum of Acacia being periodically destroyed by fire; the grasses regenerate from seed or rhizomes which establish before the *Acacia* stratum does, giving rise to a savanna. After several years the *Acacia*-dominated stratum again comes to prominence and suppresses grasses, herbs and smaller woody plants (Beard 1990).

Heading north from Broome the pindan changes with increasing rainfall, with *Acacia tumida* replacing *Acacia eriopoda* as the dominant species in the middle-stratum and *Eucalyptus tectifera* and *Eucalyptus grandifolia* replacing tree species such as *Dolichandrone heterophylla*, *Erythrophleum chlorostachys*, *Gardenia keartlandii*, *Gyrocarpus americanus* and *Lysiphyllum cunninghamii*, which are dominant in the tree stratum further south of Broome. *Plectrachne pungens* and *Chrysopogon fallax* are also dominant grass species north of Broome, replacing *Triodia pungens* and *Plectrachne schinzii* which dominate further south.

On the coast *Spinifex longifolius* is the principal coloniser of beach dunes, especially the foredunes. On the Dampier Peninsula thickets of *Acacia ampliceps* dominate the leeward sides of the dunes, and also mixed vine thickets occur, which are best developed in the northern peninsula, but do extend as far south as Broome (Beard 1990). Typical components in the Broome area include *Terminalia petiolaris, Grewia breviflora, Pouteria sericea* and *Celtis philippinensis* with other pindan species and *Acacia* species.

Beard (1979) split the Dampier Botanical District into eight different Regions, including the Dampier Peninsula. The vegetation of the sandplain area is covered by pindan formation, which differs from the pindan further south (of the La Grange Plateau Region). The

vegetation is characteristically an open layer of trees (12-15m high) over typical pindan layer of dense *Acacia* (to 5m) over sparse grassy ground layer.

Heading north of Broome towards Beagle Bay the dominant tree species are *Eucalyptus polycarpa* and *E. papuana* forma with *E. setosa, Erythrophleum chlorostachys, Gyropcarpus americanus* and *Lysiphyllum cunninghamii*. *Acacia eriopoda* (with occasional *A. holosericea*), *Dolichandrone heterophylla, Gardenia keartlandii, Grevillea refracta, G. heliosperma, Hakea arborescens, H. macrocarpa, Petalostigma pubescens* and *Terminalia circumalata* dominate the pindan layer, over *Plectachne pungens* and *Chrysopogon* (Beard 1979). Approximately 25km north of Broome the vegetation changes, with the tree stratum increasing in height and consisting of *Eucalyptus tectifica* and *E. grandifolia*, and *Acacia tumida* replaces *Acacia eriopoda*. Beard (1979) mapped the survey area as Pindan woodland on extensive monotonous sandplain.

The survey area is situated in the Dampierland IBRA Region (Department of Environment and Heritage 2000), specifically within the DL2 (Pindanland) Subregion (Graham 2001). Broadscale mapping of the DL2 Subregion includes the following vegetation types:

- Mangroves
- Coastal dune communities
- Ephemeral herblands and/or grasslands with scattered low trees
- Mixed species tussock grasslands or sedgelands +/- emergent *Pandanus* sp. (screw palm)
- *Eucalyptus tectifera* (Darwin Box), *Corymbia flavescens* woodland with *Acacia tumida* (pindan wattle) open scrub and *Chrysopogon* spp. (ribbon grass) and *Triodia bitextura* grasses
- *Eucalyptus tetrodonta* (Darwin stringybark), *Eucalyptus miniata* (Darwin woollybutt) +/- *Eucalyptus* spp. +/- *Livistona* spp. (fan palms) woodlands with a ground layer of tussock grasses and *Triodia bitextura*
- *Melaleuca citrolens* (lemon-scented teatree) with *Melaleuca* spp. (paperbark) low woodland with sparse *Chrysopogon fallax* (golden beard grass) tussock grasses
- *Adansonia gregorii* (boab), *Bauhinia cunninghamii* and *Grevillea striata* (beefwood) grassy low open-woodland
- *Corymbia dampieri* low open-woodland with *Acacia* spp. shrubs and *Triodia pungens* (soft spinifex) and *Triodia bitextura* hummock grasses
- *Eucalyptus brevifolia* (snappy gum) low open woodland with *Triodia* spp. (spinifex) hummock grasses or sometimes a hummock grassland without trees
- *Acacia ancistrocarpa* (Fitzroy Wattle) and/or *Acacia eriopoda* (Broome pindan wattle) and/or *Acacia monticola* (Gawar) tall shrubland with *Triodia intermedia* (lobed spinifex) and *Triodia pungens* (soft spinifex) hummock grasses
- *Grevillea refracta* +/- *Hakea lorea* corkwood open-shrubland with *Triodia pungens* (soft spinifex) hummock grasses
- *Triodia pungens* (soft spinifex) and/or *Triodia schinzii* hummock grassland wooded with low trees and *Acacia* spp. shrubs

Within the Dampier Peninsula, the vegetation derives from a mix of species from the deserts to the south, and monsoonal areas to the north (Kenneally *et. al.* 1996); there is a scarcity of

endemic flora species as a result. A total of 11 vegetation types are known from the Dampier Peninsula, the majority of which occur on coastal and marine environments on the edge of the Peninsula, with the Pindan dominating the interior. A brief description of these plant communities are given in Table 2.

Table 2: Vegetation Types of the Dampier Peninsula (Kenneally *et. al.* 1996)

Vegetation Type	Description
Pindan	Dominates the red sandplains of the Peninsula. It is composed of a grassed woodland, with a sparse upper layer of mainly eucalyptus over dense thicket of wattles. Fire is the main controlling agent, with the density of particulary the wattles relating directly to the fire cycle. *Acacia eriopoda* dominates the middle stratum in the southern half of the Peninsula, with *Acacia tumida* dominating the northern half.
Fitzroy sandplains	Occurs north-east of Broome towards Derby, the Fitzroy sandplain is associated with the Fitzroy drainage basin, with an obvious change being the introduction of *Adansonia gregorii* (boabs). The soils are mainly heavy yellow clay loams. Savanna dominated by *Eucalyptus tectifera* and *Lysiphyllum cunninghamii* replaces pindan vegetation, and is generally heavily grazed.
Rocky outcrops	Rare on the Peninsula, and include coastal limestones and sandstones, some of which are heavily ferruginised. Broome Sandstone is exposed on the coast as mudstone and red eroding claystone, and can support thickets of *Acacia tumida*, with *Gyrocarpus americanus* and *Ficus opposita* being common. Melligo Sandstone supports various types of vegetation depending upon location. The Emeriau Sandstone outcrops are heavily ferruginised, with few locations, best seen at the Carnot-Kings Peak area. Vine thickets are found in these areas.
Creeks, wetlands and seepage areas	Low-lying sandplains associated with sub-coastal drainage valleys and seasonaly swampy areas occur on the northern peninsula, including near Martins Well, just north of Pender Bay, south of Rumble Bay, areas inland of Beagle Bay and Pender Bay. Riverine communities also occur in the Coulomb Point Nature Reserve, supporting low closed forests of *Melaleuca acacioides*. Freshwater swamps occur in areas where coastal dunes truncate drainage lines, supporting low woodlands of *Lophostemon grandiflorus* subsp. *grandiflorus*, fringed by *Melaleuca nervosa* and *M. acacioides.* Small seasonal claypans and swamps occurrig further inland also occur, supporting a fringing low woodland of *Lophostemon grandiflora* and/or *Melaleuca acacioides* with *M. viridiflora* or *M. nervosa.* *Melaleuca cajuputi* and *M. viridiflora* groves are supported near areas of permanent fresh water; these areas also contain *Nymphoides beaglensis*, which is endemic to the Peninsula. Mound springs, including the Bunda-Bunda mound spring also locally occur, as well as Nimalaica Claypan, inland from Willie Creek. TheFitzroy River is one of the largest permanent rivers in the Kimberley, supporting dense riverine vegetation found nowhere else on the Peninsula.
Vine Thickets	Vine thickets are found in discontinuous and discrete pockets of relatively dense vegetation directly behind coastal dune systems. They are allied to rainforest, and contain a predominance of Indo-Malesian plant species. Further north from the Peninsula vine thickets are not associated with coastal dunes, but with rocky sites. Vine Thickets are best developed northwards along the Peninsula, and are an important habitat for species such as the great bower bird, rose-crowned fruit pigeon and agile wallaby.

Table 2: Vegetation Types of the Dampier Peninsula (Kenneally *et. al.* 1996)	
Vegetation Type	**Description**
Coastal dunes, beaches and limestone otucrops	Holocene sand dunes run parallel to the coast, with large areas of mobile dunes encroaching inland in the northern Peninsula. Foredunes are sparsely vegetated, predominantly with Spinifx longifolius, and more patchily with *Fimbristylis cymosa*, *F. sericea* and *Cyperus bulbosus*. *Acacia bivenosa*, *Lysiophyllum cunninghamii* and *Canavalia rosea* are found on areas of more established dunes. Dense shrub communities are found behind the dune crets, on backslopes and hollows. Pleistocene dunes which are older and less exposed, have more species in common with thepindan; they are dominated by *Acacia monticola* and *Gyrostemon tepperi*, as well as *Plectrachne schinzii* in areas that have not been burnt. These areas can also contain the locally important community containing an open eucalypt community with several bloodwood species. Coastal and sub-coastal limestone outcrops occur sporadically, with *Acacia bivenosa* characteristic of these areas south of Barred Creek. North of Barred Creek *Acacia bivenosa* does not occur and the area is poorly vegetated. A karst formation is found on Packer Island.
Saline grasslands	*Sporobolus virginicus* grasslands are found on tidal flats above the high-water mark. Near Broome this is best developed on the Roebuck Plains, inland from Crab Creek. This formation is found widely across the Peninsula. These areas are subject to flooding and ponding after monsoonal rains.
Saltwater paperbark thickets	Fringing stands of *Melaleuca acacioides* are found on the inner, landward amrgin of saline grasslands; the width and density of this community varies from a discontinuous line to half a kilometre thick.
Samphire flats	Tidal flats occurring behind Mangroves feature wide expanses of bare mud, with *Ceriops tagal* and *Excoecaria agallocha* found on the seaward margins of the mud flats. Samphire species dominate the landward side, including *Halosarcia halocnemoides*, *Neobassia astrocarpa* and *Suaeda arbusculoides.*
Mangroves	12 of the 17 mangrove species known in the State are located within the Peninsula. *Avicennia marina* is the commonest species. These areas are located between high spring tide and mean sea level.
Seagrass Meadows	Most species of seagrass occur on a wide range of sediments in the Peninsula. Extensive seagrass banks are found at Roebuck Bay, with *Halophila ovalis* and *Halodule uninervis* common in this area.

2.3.2 Local Vegetation Units

Trudgen (1988) undertook a flora and vegetation survey of the Broome coastline extending northwards from Riddell Point to a location 3.5km north of the Cable Beach resort area. The vegetation was initially split up into categories including vegetation of the Strand area, Dunal vegetation, Pindan vegetation, Vine Thicket and related vegetation (Gubinge Woodlands), and *Melaleuca* open forest. These vegetation units are presented in Table 3.

A short description of vegetation communities within the Port Management Area (PMA) is given in URS (2004), as described below.

- Dunal vegetation varies with dune aspect, slope and shoreline proximity, with species such as *Spinifex longifolius*, *Canavalia rosea* and *Acacia bivenosa* colonising eroding seaward faces; whereas the seaward ridge and backslopes are colonised by species such as *Crotolaria cunninghamii*, *Marsdenia cinerascens*, *Santalum lanceolatum* and *Acacia bivenosa*.
- Discontinuous vine thickets occur in depressions and swales between dune ridges, with species such as *Gyrocarpus americanus*, *Abrus precatorius*, *Passiflora foetida*, *Tinospora smilacina* and *Capparis lasiantha* present.
- Eucalypt and Gubinge woodland over hummock grassland of *Plectrachne pungens* occur on inland dune ridge and slopes, with other species such as *Gardenia pyriformis* and *Clerodendrum tomentosum* also present. These woodlands merge with Pindan vegetation where the rearward dunes slope down onto the Pindan plain.
- Pindan vegetation present lying between Port Drive and the base of the dunes is typical of the area, and is comprised of mixed Acacia/Eucalypt woodland including *Acacia eriopoda*, *Eucalyptus dampieri* and *Terminalia petiolaris* with scattered shrubs and grasses including *Lysiphyllum cunninghamii*, *Hakea macrocarpa* and *Ventilago viminalis*.
- Mangrove communities in the PMA were noted by URS (2004) to be limited to minor patches along the Roebuck Bay shoreline.

It has been noted that vegetation communities vary significantly on the Broome Peninsula moving northwards from the Port of Broome (Urbanplan 2006). This is due to the effect of the ocean on the climate at either end of the Broome Peninsula.

Table 3: Vegetation Units on the Broome Coastline as described by Trudgen (1988)		
Group	**Vegetation Unit**	**Description**
The Strand	Cm: *Canavallia rosea* herbland	Unit occurred on a narrow strip along the base of the dunes; consisted of very open vegetation with small amounts of *Canvallia rosea*, *Spinifex longifolius* and *Salsola kali*; *Ipomoea pes-caprae* was also present
Holocene and Pleistocene Dunes (Coastal)	Sl: S*pinifex longifolius* dense hummock grassland	Unit occurred on very small and young dunes of white beach sand on base of low Pindan cliff; dense cover of *Spinifex longifolius* with *Canavallia rosea* and small amounts of *Salsola kali* and *Panicum* sp.
	AbCcSl: *Acacia bivenosa*, *Crotalaria cunninghamii* shrubland over *Spinifex longifolius* mid-dense hummock grassland	Unit occurred on Holocene white sand dunes fronting on Cable Beach, extending to the swale to the second stabilised dune; upper shrub layer of *Acacia bivenosa* and *Crotalaria cunninghamii* over mid-dense layer of *Spinifex longifolius* with *Chamaesyce* sp., *Salsola kali* and *Canavalia rosea*.
	AbCc: *Acacia bivenosa*, *Crotalaria cunninghamii* shrubland	Unit occurred on seaward face and crest of second stabilised dune; shrub layer of *Acacia bivenosa* and *Crotalaria cunninghamii*; no layer of *Spinifex longifolius*, and *Canavalia rosea* and *Salsola kali* occur only on disturbed areas; other species noted were *Santalum lanceolatum*, *Tephrosia rosea*, *Mallotus nesophilus*, *Whiteochloa airoides*, *Chamaescyce* sp., *Boerhavia* sp. and *Tinospora smilacina*
	AbSl: *Acacia bivenosa*, *Crotalaria cunninghamii* open heath over *Spinifex longifolius* hummock grassland	Unit occurred on Pleistocene dunes close to the beach; has shrub layer of *Acacia bivenosa* and *Crotalaria cunninghamii* over hummock grassland of *Spinifex longifolius*; other species present including *Tinospora smilacina*, *Mukia maderaspatana*, *Chamaesyce* sp., *Tephrosia rosea*, *Gyrostemon tepperi*, *Crotalaria medicaginea*, *Lysiana spathulata*
	AbPh: *Acacia bivenosa*, *Crotalaria cunninghamii* shrubland over *Plectrachne helmsii* mid dense hummock grassland	Unit occurred behind AbSl, with same dominant species in the shrub layer; *Plectrachne helmsii* however is dominant understorey species; *Tephrosia rosea*, *Chamaescyce* sp. and *Gyrostemon tepperi* also present.
	LcAbCcWa: *Lysiphyllum cunninghamii* high oepn shrubland over *Acacia bivenosa*, *Crotalaria cunninghamii* open shrubland to open heath over *Whiteochloa airoides* open grassland to grassland	Unit occurred on irregular upper parts of Pleistocene dunes along the east side of 'Hidden Valley'; species included *Lysiphyllum cunninghamii*, *Terminalia petiolaris*, *Acacia bivenosa*, *Crotalaria cunninghamii*, *Marsdenia cinerascens*, *Tephrosia rosea* and *Whiteochloa airoides*.
Inland Dunes	PtEzPh: *Pouteria sericea*, *Eucalyptus zygophylla*, *E. damperi* low woodland over *Plectrachne helmsii* mid dense hummock grassland	Unit occurred on dune that runs roughly WSW-ENE in the area of Gantheaume Point; open woodland of *Pouteria sericea*, *Eucalyptus zygophylla* and *Eucalyptus dampieri* with occasional *Lysiphyllum cunninghamii* and *Gyrocarpus americanus*; with a shrub layer of *Carissa lanceolata*, *Santalum lanceolatum*, *Acacia holosericea*, *Acacia tumida*, *Distichostemon hispidulus*, *Hakea macrocarpa* and *Erythrophloeum chlorostachys*.
Vine Thickets and deciduous woodlands to forests	Mn: *Mallotus nesophilus* open scrub	Unit occurred on the lee slope of the secon ddune from the beach near the southern end of Cable Beach; moderately dense cover of *Mallotus nesophilus*, above *Flueggea virosa*, *Santalum lanceolatum* and *Grewia breviflora*.

Table 3:	**Vegetation Units on the Broome Coastline as described by Trudgen (1988)**	
Group	**Vegetation Unit**	**Description**
	EcAbFv: *Eucalyptus confertiflora* low open woodland over *Acacia bivenosa*, *Flueggea virosa* open heath	Unit occurred on the bottom of the lee side of the inland dune at the south end of Cable Beach on pindan soil; scattered *Eucalytpus confertiflora* over *Acacia bivenosa*, *Flueggea virosa*, *Grewia breviflora*, *Carissa lanceolata*, *Jasminum didymum*, *Marsdenia cinerascens*, *Plectrachne helmsii*.
	LcOaMn: *Lysiphyllum cunninghamii*, *Opilia amentacea*, *Mallotus nesophilus* open heath	Unit occurred on the leeward slope of the inland dune behind Cable Beach; contains *Lysiphyllum cunninghamii*, *Mallotus nesophilus*, *Opilia amanateacea*, *Myopogoum acuminatum*, *Marsdenia cinerascens*, *Carissa lanceolata*, *Jasminum didymum*, *Amyema benthamii*, *Whiteochloa airoides*, *Santalum lanceolatum*, *Opilia amantacea*.
	GaPaFvGb: *Gyrocarpus americanus*, *Premna acuminata*, *Lysiphyllum cunninghamii* low woodland over *Flueggea virosa*, *Grewia breviflora* high shrubland to open scrub	Unit occurred on the flat area of Pindan soil behind dunes parallel to Cable Beach, on richer soil and higher moisture availability; contained *Gyrocarpus americanus*, *Premna acuminata*, *Ehretia saligna*, *Eucalyptus confertiflora*, *Pouteria sericea*, *Lysiophyllum cunninghamii*, over shrubs of *Grewia breviflora* and *Flueggea virosa*; other species present including *Terminalia ferdinandiana*, *Mallotus mesophilus*, *Marsdenia cinerascens*, *Carissa lanceolata*, *Abutilon indicum*, **Passiflora foetida*, *Plectrachne helmsii*.
	TpMc: *Terminalia petiolaris*, *Clerodendrum tomentosum*, *Pouteria sericea* low woodland over Grewia *breviflora*, *Marsdenia cinerascens* high shrubland over *Triodia pungens* hummock grassland	Unit occurred on dunes behind Cable Beach on white sand over orange-pink sand; tree layer of *Terminalia petiolaris*, *Clerodendrum tomentosum*, *Pouteria sericea* over open shrub/vine layer of *Grewia breviflora*, *Marsdenia cinerascens*, *Flueggea virosa* with other species such as *Amyema benthamii*, *Acacia bivenosa*, *Myoporum acuminatum*, *Santalum lanceolatum* and *Tephrosia rosea* present, over *Triodia pungens* and *Whiteochloa airoides*.
	LcGbFv: *Lysiphyllum cunninghamii* high oepn shrubalnd over *Grewia breviflora*, *Mallotus nesophilus* high shrubland over *Flueggea virosa* shrubland	Unit occurred in a swale between two dunes next to Cable Beach; scattered *Terminalia petiolaris* with *Lysiphyllum cunninghamii* over *Mallotus nesophilus* and *Grewia breviflora* over lower shrub/vine layer of *Flueggea virosa*, *Tinospora smilacina*, *Myoporum acuminatum*, *Opilia amentacea* and *Tephrosia rosea*.
	FvLcAb: *Flueggea virosa*, *Lysiphyllum cunninghamii*, *Acacia bivenosa* open scrub	Unit occurred Top of south-east facing slope of Pleistocene dune inland from Bali-Hai; transitional from the heath/shrubland vine thicket to the *Acacia bivenosa* units of the dunes; *Flueggea virosa*, *Lysiphyllum cunninghamii*, *Acacia bivenosa* and *Grewia breviflora* with *Tinospora smilacina*, also *Crotalaria cunninghamii*, **Passiflora foetida*, *Chamaescyce* sp., *Ficus opposita*, *Marsdenia cinerascens*, *Tephrosia rosea*, *Bridelia tomentosa*, *Trichodesma zeylanica*, *Caesalpinia major*, *Terminalia petiolaris*, *Lysiana spathulata*, *Jasminium didymum* and *Whiteochloa airoides*.

Table 3: Vegetation Units on the Broome Coastline as described by Trudgen (1988)		
Group	**Vegetation Unit**	**Description**
Vine Thickets and deciduous woodlands to forests (cont.)	TPMaFv: *Terminalia petiolaris* low open woodland over *Myoporum acuminatum* high shrubland to open scrub over *Flueggea virosa* high shrubland	Observed at 'Hidden Valley', broad swale between Holocene and Pleistocene dunes to the north of Bali-Hai; scattered *Terminalia petiolaris* over *Myoporum acuminatum*, *Grewia breviflora* and *Mallotus nesophilus*; over *Flueggea virosa*; with other species including *Ficus opposita*, *Exocarpos latifolius*, *Acacia bivenosa*, *Bridelia tomentosa*, *Marsdenia cinerascens*, *Adriana tomentosa*, *Hypoestes floribunda*, *Plectrachne helmsii*, *Clerodendrum tomentosum* and *Caesalpinia major*.
	Ah: *Atalaya hemiglauca* low open forest to low closed foreset	Two stands of this unit were recorded, with dense cover of *Atalaya hemiglauca* over very sparse understorey.
***Terminalia ferdinandiana* ('Gubinge') Woodlands**	Tf: *Terminalia ferdinandiana* open woodland ovr *Eucalyptus confertiflora*, *Pouteria sericea* low open woodland	Unit occurred on pindan soils; open cover of *Terminalia ferdinandiana* over *Pouteria sericea* and *Eucalyptus confertiflora*, over mixed shrub layer with *Hakea arborescens*, *Ficus opposita*, *Jasminum didymum*, *Ehretia saligna*, *Flueggea virosa*, *Grewia polygama*, *Carissa lanceolata* and *Streptoglossa macrocephalus* over *Plectrachne helmsii*.
	TfEcEdPs: *Terminalia ferdinandiana*, *Eucalyptus confertiflora*, *Eucalyptus dampieri*, *Poulteria sericea* low woodland	Unit occurred on pindan soils on flat to slightly sloping area behind dunes next to Cable Beach; tree layer including *Terminalia ferdinandiana*, *T. petiolaris*, *Pouteria sericea*, *Eucalyptus dampieri*, *Eucalyptus confertiflora*, *Exocarpos latifolius*, *Ehretia saligna* and *Lysiphyllum cunninghamii* over diverse shrub layer of various species over grass layer dominated by *Plectrachne helmsii* with *Aristida brownii* and *Eriachne* sp.
Pindan	AtGp: *Acacia tumida*, *Grevillea pyramidalis* oepn heath over *Plectrachne helmsii* hummock grassland with *Eriachn*e sp. and *Eragrostis eriopoda*	Unit occurred on pindan with thin sand overlay with no dunal protection from winds, dominated by *Acacia tumida* and *Grevillea pyramidalis* with scattered *Eucalyptus confertiflora* and *Gyrostemon tepperi*, *Distichostemon hispidulus*, *Solanum cunninghamii*, *Persoonia falcata*, *Dolichandrone heterophylla*, *Gardenia pyriformis* and *Terminalia ferdinandiana*, over *Plectrachne helmsii* with other species such as *Triodia pungens*, *Eragrostis eriopoda* and *Eriachne* sp.
	EahPh: *Eucalyptus* aff. *aspera*, *Eucalyptus zygophylla* low open woodland over *Acacia holosericea* shrubland to open heath over *Plectrachne helmsii* hummock grassland to mid dense hummock grassland	Unit abuts Pleistocene dunes, however can also abut Holocene dunes; tree layer of *Eucalyptus* aff. *aspera* and *Eucalyptus zygophylla* with *Hakea macrocarpa* and *Erythropleum chlorostachys* over shrubland to open heath of *Acacia holosericea*, with other shrubs including *Grevillea pyramidalis*, *Ehretia saligna*, *Ficus opposita*, *Persoonia falcata* and *Terminalia ferdinandiana*, *Dolichandrone heterophylla*, *Gardenia pyriformis* and *Gyrostemon tepperi*, over *Plectrachne helmsii*.
	EcPh: *Eucalyptus confertiflora*, *E. dampieri* and *E. zygophylla* low open woodland over *Plectrachne helmsii* mid dense hummock grassland	Unit occurred on flat to gently sloping Pindan; low *Eucalyptus* trees with *Eucalyptus confertiflora* being most dominant over mixed shrub layer including *Ehretia saligna*, *Ficus opposita*, *Erythrophleum chlorostachys*, *Gardenia pyriformis*, *Grewia polygama*, *Gossypium australe*, *Dolichandrone heterophylla* and *Persoonia falcata* over *Plectrachne helmsii.*

Table 3: Vegetation Units on the Broome Coastline as described by Trudgen (1988)		
Group	**Vegetation Unit**	**Description**
Pindan (cont.)	EcTfE: *Eucalyptus confertiflora*, *Terminalia ferdinandiana* shrubland over *Eriachne* sp. and *Plectrachne helmsii* grassland	Unit occurred on pindan slope above the beach on the north side of Gantheaume Point; dominated by *Eucalyptus confertiflora* and *Terminalia ferdinandiana* with *Persoonia falcata*, *Santalum lanceolatum* and *Grevillea pyramidalis* over *Eriachne* sp. and *Plectrachne helmsii.*
	EcAhPh: *Eucalyptus confertiflora* low open woodland over *Acacia holosericea* high open shrubland over *Plectrachne helmsii* mid dense hummock grassland	Unit occurred upslope of EcTfE; has a taller and more open stratum of *Eucalyptus confertiflora* over *Acacia holosericea* and *Lysiphyllum cunninghamii* over shrubs including *Terminalia ferdinandiana*, *Santalum lanceolatum*, *Gardenia pyriformis*, *Hakea macrocarpa*, *Grevillea pyramidalis*, *Erythrophleum chlorostachys* and *Distichostemon hispidulus*, over *Plectrachne helsmii* with *Eragrostis eriopoda* and *Eriachne* sp.
	EdHaPh: *Eucalyptus dampieri* low woodland over *Hakea arborescens* high shrubland over *Plectrachne helmsii* mid dense hummock grassland	Unit occurred on pindan red sand gently sloping to the base of dunes behind Cable Beach; *Eucalyptus dampieri* is the most abundant tree with *Eucalyptus confertiflora* and *Eucalyptus zygophylla* also present, over a shrub layer dominated by *Hakea arborescens* with *Acacia holosericea* and other shrub species over *Plectrachne helmsii*.
	EdAeAPh: *Eucalyptus dampieri* low open woodland over *Acacia eriopoda* open scrub over *Adriana tomentosa* shrubland over *Plectrachne helmsii* mid-dense hummock grassland	Unit occurred on undulating pindan soil in 'Hidden Valley' enclosed by Holocene and Pleistocene dunes; open tree layer of *Eucalyptus dampieri* over upper shrub layer of *Acacia eriopoda* and some *Hakea arborescens*, above *Adriana tomentosa*, *Tephrosia rosea* and *Crotalaria medicaginea* over *Plectrachne helmsii*.
	EdAeHPh: *Eucalyptus dampieri* low open woodland over *Acacia eriopoda*, *Hakea macrocarpa*, *Hakea arborescens* open scrub over *Plectrachne helmsii* mid dense hummock grassland	Unit occurred on pindan soil on a slight slope into the vine thicket area; open tree layer of *Eucalyptus dampieri* with occasional *Eucalyptus confertiflora* over shrubs dominated by *Acacia eriopoda* with *Hakea macrocarpa*, *Hakea arborescens*, and *Acacia holosericea*, *Ventilago viminalis*, *Lysiphyllum cunninghamii* and *Ehretia saligna* over *Plectrachne helmsii* and other grasses.
***Melaleuca* woodlands to forests**	Md: *Melaleuca dealbata* low open forest	Unit occurred in 'Hidden Valley' on and between Holocene dunes; dense areas contain *Melaleuca dealbata* over *Terminalia petiolaris*, *Mallotus nesophilus*, *Myoporoum acuminatum*, *Flueggea virosa*, *Marsdenia cinerascens*, *Jasminum didymum*, *Cassytha filiformis*, *Ptilotus exaltatus*, *Acacia bivenosa* and *Whiteochloa airoides*; in areas of less-dense *Melaleuca* cover, the cover is predominantly dune vegetation species such as *Acacia bivenosa* and *Myoporum acuminatum* rather than vine thicket species.
Degraded Areas	CC: **Cenchrus ciliaris* grassland	Occurred in an area on Gantheaume point that had been badly degraded with the shrub layer removed; also included what was thought to be a native grass of the genus *Sorghum*.
	Am: *Acacia monticola* 'heath'	Occurred around Gantheaume Point, in an area where stripping of a layer of lateritic material for roadworks had occurred; *Acacia monticola* with *Goodenia scaevolina*, *Cassytha filiformis* and *Gyrostemon tepperi* were still present.

2.3.3 Threatened and Priority Ecological Communities

A total of five Threatened Ecological Communities (TECs) and eight other ecosystems at risk are also listed for the DL2 Subregion, as listed on Table 4 (based on information from Graham (2001); cross-checked against DEC 2006 (b)). TECs and Priority Ecological Community (PEC) conservation status descriptions are given in Appendix A.

Table 4: Threatened Ecological Communities (TECs) and other Ecosystems at Risk known in the DL2 Subregion (Graham 2001)

Ecosystem (DEC 2006b; 2008)	Ecosystem Description	Conservation Status
67. Monsoon Thickets	Monsoon (vine) thickets on coastal sand dunes of the Dampier Peninsula	V
44. Roebuck Bay Mudflats	Species-rich faunal community of the intertidal flats of Roebuck Bay	V
85. Bunda Bunda	Bunda Bunda organic mound spring communities	V
95. Mandora Mound	Assemblages of the organic springs and mound springs of the Mandora Marsh area	V
13. Kimberley	Disaster Bay organic mound spring communities	Priority 3 (iii) *
	Assemblages of permanent/ephemeral wetlands, damplands, and riparian habitat of the Dampierland Region	V **
14. Kimberley	Organic mound spring communities of the Lolly Well spring	P3 (ii) *
15. Kimberley	Nimalaica clay pan community, inland from Willie Creek	P4 (b)
	Saline grasslands on tidal flats above high water mark (*Sporobolus virginicus* dominated) on Dampier Peninsula/Broome area	P1
	Vine thickets on heavily ferruginised Emeriau sandstone on Dampier Peninsula	
	Flora and Fauna assemblages of of spring communities Logues Spring, south-west Kimberley Edgar Range near Dampier Downs	
	Assemblages of Culla Culla Creek – unusual spring site in Dampierland	
	Assemblages of Taylors Lagoon, Lake Campion, and Lake Eda	V **

Note: * Conservation Status listing as per DEC (2006b; 2008)
Note: ** Noted as 'V' (Vulnerable) by Graham (2001); no such listing under DEC (2006b; 2008)

The TEC and PEC listings (DEC 2006; 2008a) list five TECs and five PECS in the Dampierland Region, as listed in Table 5. Of these, TEC 67 (Monsoon Thickets), and PECS 10. Kimberley (Dwarf pindan heath community of Broome coast) and 11. Kimberley (*Corymbia paractia* dominated community on dunes) are known from within the survey area.

Table 5: Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) listed within the Dampierland Region (DEC 2006; 2008b)		
TEC / PEC	**Description**	**Conservation Status**
44. Roebuck Bay Mudflats	Species-rich faunal community of the intertidal mudflats of Roebuck Bay	VU B)
67. Monsoon Thickets	Monsoon (vine) thickets on coastal sand dunes of Dampier Peninsula	VU C)
85. Bunda Bunda	Assemblages of Bunda Bunda organic mound spring	VU A); VU B)
86. Big Springs	Assemblages of Big Springs organic mound springs	VU A); VU B)
95. Mandora Mounds	Assemblages of the organic springs and mound springs of the Mandora Marsh area	EN B) iii)
10. Kimberley	Dwarf pindan heath community of Broome coast	Priority 1
11. Kimberley	*Corymbia paractia* dominated community on dunes	Priority 1
13. Kimberley	Assemblages of Disaster Bay organic mound springs. Organic mound spring son tidal flat with *Melaleuca acacioides, Timontius timon, Pandanus spiralis, Melaleuca viridiflora, Acacia neurocarpa* and *Lumnitzera racemosa* (mangrove) woodland with *Typha domingensis* and sedges, including *Schoenoplectus litoralis*	Priority 3 (iii)
14. Kimberley	Assemblages of Lolly Well Springs wetland complex. Wetland complex containing numerous low organic mound springs with moats.	Priority 3 (ii)
15. Kimberley	Nimalaica clay pan community. Inland from Willie Creek.	Priority 4 (b)

TEC 67 (Monsoon Thickets) are located on the inland side of coastal dunes along the Dampier Peninsula, and tend to become larger and have greater species diversity in a northwards direction. Near Broome distinctive components of this community include *Pouteria sericea, Exocarpos latifolius, Grewia breviflora, Grewia retusifolia, Pavetta kimberleyana, Bridelia tomentosa, Premna acuminata, Terminalia petiolaris* and *Terminalia ferdinandiana*. Another significant area of vine thickets includes an area northwards from Barred Creek towards Quondong to James Price Point, where *Diospyros ferrea* var. *humilis, Mimusops elengi, Celtis philippensis, Melaleuca dealbata* and more rarely *Parinari nonda* and *Pittosporum molluccanum* are located, as well as *Glycosmis* spp. and *Croton habrophyllus*. Common vines located within Vine Thickets include *Abrus precatorius, Gymnanthera oblonga, Jacquemontia paniculata, Passiflora foetida, Tinospora smilacina, Tylophora cineracens* and *Operculina brownii, Opilia amentacea, Caesalpinia major, Capparis lasiantha, C. sepiaria, Paramignya trimera* and *Protasparagus racemosus* (Kenneally *et. al.* 1996).

PEC 11. Kimberley (*Corymbia paractia* dominated community on dunes) is common between Gantheaume Point and Cable Beach, however it is apparently restricted to a narrow coastal zone in the Broome area where beach dunes merge into pindan soils (Kenneally *et. al.* 1996), and is often found mixed with rainforest (monsoon) species (Kevin Kenneally and Val English *pers. comm*).

PEC 10 Kimberley (Dwarf pindan heath community of Broome coast). This community was described by Trudgen (1988) as 'AtGp' on pindan soils (Table 3), and is a reference to *Acacia tumida* var. *kulpan*, which occurs on coastal cliffs at Gantheaume Point and James Price Point as a wind pruned shrub to 50cm in height (Kevin Kenneally and Val English, *pers. comm*.). This vegetation type is discussed in Broome Botanical Society Inc. (1995), where it is located on the near-coastal hinterland from Gantheaume Point past Riddell Beach towards the Port of Broome. PEC 10's characteristics include low-profile wind-sheared shrubs, small areas of almost monotypic spinifex grasslands and traces of residual Pleistocene linear dunes.

2.4 Flora

2.4.1 Regional and Local Flora

Beard (1990) described the flora species of the Northern Province as being classified as either:

- Perennial drought-resisting species (all leaves and stems remain in a growing condition throughout the year; includes most tree and shrub species, as well as *Triodia* spp.);
- Perennial drought-evading species (leaves die at the end of the wet season, with new growth occurring the following wet season originating from vegetative organs; includes most perennial tussock grasses, and deciduous trees and shrubs); and
- Annual drought-evading species (plants germinate from seed each growing season; includes most forbs and short grasses, however also some tall annual grasses).

Kenneally *et. al.* (1996) record a total of 717 known plant taxa occurring on the Dampier Peninsula, of which 649 are native, and 68 are introduced. The largest families include Poaceae (84 taxa), Papilionaceae (50 taxa) and Cyperaceae (36 taxa). A total of 2080 plant taxa, including 1973 native and 108 introduced plant taxa, are recorded in the Kimberley Region (Wheeler J. R. (ed) (1992)).

Trudgen (1988) recorded a total of 117 native plant taxa, from 50 families, during his survey of the Broome Coastline. The most commonly recorded families were Poaceae (11 taxa), Euphorbiaceae (8 taxa), Papilionaceae (8 taxa), Mimosaceae (7 taxa) and Malvaceae (7 taxa). None of the taxa collected were known to be rare or geographically restricted, however the vine thicket areas near Broome are the most southerly-known in Western Australia and contain the most southerly populations of many species contained within them (Trudgen 1988).

2.4.2 Declared Rare and Priority Flora

A relatively small proportion of the State's conservation significant (Declared Rare Flora (DRF) and Priority Flora) species are located within the Kimberley Region, with 158 of the 2813 State-listed species known from the Region (5.6%) (DEC 2008a). Appendix B presents descriptions of DRF and Priority flora conservation status.

Within the DL2 (Pindanland) Subregion, 19 species of conservation significance are known, including two DRF species, as listed in Table 6 (Graham 2001; DEC 2008c)

Table 6: Declared Rare and Priority flora known from the Dampierland Subregion (Graham 2001; DEC 2008c)

Species	Conservation Status	Comments
Keraudrenia exastia	DRF (CR)	Perennial shrub; flowering April-December; red sand in pindan, coastal site, relict desert dune swale; known from Broome area
Pandanus spiralis var. *flammeus*	DRF (E)	Perennial tree-like monocot; white clay, springs; known from Edgar Range, south-east of Broome
Cullen candidum	P1	Perennial shrub; flowering May-October, clayey sand; known from northern tip of Dampierland
Glycine pandanica	P1	Perennial herbaceous climber; flowering February-March/June; pindan soils; known from vicinity of Broome
Ipomaea sp. Kimberley Flora (L. J. Penn 84)	P1	Creeping/twining perennial herb; flowering June; shallow soils on sandstone; known from north-east of Broome
Nicotiana heteranthera	P1	Short-lived annual or perennial herb; flowering March-June/September; black clay, seasonally wet flats; known from vicinity of Broome
Sauropus salignus	P1	Annual herb; flowering March-June; basalt rocks
Tephrosia andrewii	P1	Perennial shrub; flowering April/October; sand, pindan; known from south of Broome
Tetragonia coronata	P1	Annual herb; flowering June; red clay-loam, calcrete outcrops; known from vicinity of Broome
Gomphrena pusilla	P2	Annual; flowering March-June; fine beach sand, on limestone behind foredune
Nymphoides beaglensis	P2	Aquatic annual herb; flowering March-June; shallow freshwater, edges of permanent waterholes or seasonally inundated claypans and depressions
Pterocaulon sp. A. Kimberley Flora (B. J. Carter 599)	P2	Perennial shrub; flowering April-August; coastal areas, saline flats, pindan sandplain; known from vicinity of Broome, and north of Broome
Aphyllodium glossocarpum	P3	Perennial shrub; flowering April-October; sand, pindan; known from north of Broome
Acacia glaucocaesia	P3	Perennial shrub; flowering July – September; red loam, sandy loam, clay, floodplains; known from south-west of Broome

Table 6: Declared Rare and Priority flora known from the Dampierland Subregion (Graham 2001; DEC 2008c)		
Species	**Conservation Status**	**Comments**
Goodenia sepalosa var. *glandulosa*	P3	Sprawling herb; flowering January-December; red sand or loam; known from east of Broome
Fuirena incrassata	P3	Annual sedge; flowering May-August; sand, sandy clay, swamps, creekbeds, claypans, semi-saline lakes; known from east-north-east of Broome
Keraudrenia katatona	P3	Perennial shrub; flowering March-August; red sand, desert dunes in pindan, ranges, disturbed areas; known from vicinity of Broome
Phyllanthus aridus	P3	Perennial shrub; flowering May-June; sandstone, gravel, red sand; known from vicinity of Broome
Stylidium costulatum	P3	Annual herb; flowering April-August; sandy or clayey soils, creeks or seasonally wet areas; known from north of Broome
Triodia acutispicula	P3	Tussock-forming perennial grass; flowering January-April; sandy soils, river levees, pindan plains, rocky hillslopes and outcrops; known from east of Broome
Pittosporum moluccanum	P4	Perennial tree; flowering February-August; white sand, sand dunes; known from north of Broome

Keraudrenia exastia (DRF) is known directly from within BPA-managed lands, within the survey area. This species is known only from the Broome Peninsula, and was listed as DRF in 1999. The species is an erect, compact multistemmed shrub to 90cm high. The stems have apical branchlets with a tomentum of pale tan to white stellate hairs. The leaves are narrowly ovate, elliptic or oblong, alternate and spreading, with an entire margin, and both surfaces are covered in a pale grey-green tomentum of stellate hairs. The infloresence is a 7-9 flowered cyme, with a purple calyx, and a usually absent corolla. The species is known from relict desert dune swale in red pindan sand, mainly in *Acacia* shrubland (Wilkins 1999).

Several surveys to examine the range of this species have been undertaken. The Broome Botanical Society (Inc.) mapped seven discrete populations of this species in the vicinity of Kavite Road after field work undertaken in September 1995. Each population differed in size and density of individuals. A total number of 3360 individuals were estimated to occur in these populations. Associated vegetation was mainly relatively uniform pindan heathland, characterised by *Plectrachne schinzii* and scattered trees of *Acacia colei* and *Eucalyptus dampieri*. Threats to existing known populations included spread of introduced species (including *Aerva javanica* and *Cenchrus setiger*), presence of infrastructure such as rubbish tip, borrow pits and Kavite Road (including maintenance of the road).

Further survey of *Keraudrenia exastia* populations was undertaken by Trudgen (2006). Populations of this species were found to grow in stands of at least three different fire ages, where individuals were healthy and showed no sign of senescence. It may be that this species is not fire sensitive, and population sizes may not be significantly altered by fire. Trudgen (2006) noted that it is likely that soil or water availability habitat factors restrict the current distribution of this species, and that these factors may have some relationship to the presence

of the Holocene dunes lying to the south of the main populations of this species. Although the species was seen to grow in several vegetation types, appeared to be associated with *Acacia colei* var. *colei.* It may also be possible that microclimate factors related to the influence of the sea on the climate of the southern end of the Peninsula may also be important in influencing the distribution of *Keraudrenia exastia*.

It is also noted by Trudgen (2006) that a population of *Leptosema anomala* is located near the known populations of *Keraudrenia exastia*, and this population is disjunct from the main population of *Leptosema anomala*.

No flora species listed under the Common Environmental Protection and Biodiversity Conservation Act (1999) are present within the survey area (Department of Environment and Heritage 2008).

2.4.3 Introduced Species

Three invasive plant species or Weeds of National Significance (WONS) are either known from or have suitable habitat in the survey area, as recorded on the Commonwealth Department of Environment and Heritage databases (Department of Environment and Heritage 2008). These are detailed in Table 7, with control codes (where applicable) under the Department of Agriculture and Food (DAFWA 2008).

Table 7: Invasive weed species known from the Survey Area (Department of Environment and Heritage 2008

Species	Common Name	Status	DAFWA Control Code (Appendix E)	Description
Cenchrus ciliaris	Buffel Grass	Invasive	-	Widely planted as pasture grass; widespread weed of roadsides, creeklines, river edges and most vegetation types
Parkinsonia aculeata	Parkinsonia; Jerusalem Thorn	WONS; Declared Plant (WA)	P1 (whole of State); P4 (Broome Shire)	Grows in moist conditions along river banks and does well on tropical black soils; withstands heat and drought; Serious weed in pastoral areas in Kimberley and Pilbara Regions
Prosopis spp.	Mesquite	Declared Plant (WA)	P1 (whole of State); P2 (whole of State excluding P1 areas)	Can grow on drier soils, on floodplains and near permanent water; Reproduces by seed and suckers; Is known to lightly infest areas south of Broome

25 environmental weeds were identified during a 2004 survey of the Broome townsite (Shire of Broome 2004), the most common of which included:

- *Leucaena leucocephala* (Coffee Bush)
- *Azadirachta indica* (Neem)
- *Jatropha gossypifolia* (Bellyache Bush) (Declared Plant under the *Agriculture and Related Resources Act 1974*)
- *Macroptilium atropurpureum* (Siratro)

- *Merremia aegyptia*
- *Merremia dissecta*
- *Passiflora foetida* (wild passionfruit)
- *Tribulus terrestris* (Caltrop)
- *Alternanthera pungens* (Khaki weed)
- *Cenchrus biflorus* (Gallon's curse)

2.5 Wetlands of Significance

Five Wetlands of National Significance are known from the DL2 Subregion, including the Bunda Bund Mound Springs, Eighty Mile Beach System, Roebuck Bay, Roebuck Plains System and Willie Creek Wetlands (Graham 2001).

Roebuck Bay is a listed RAMSAR wetland (Number 33) (DEH 2008). This site is located on Roebuck Bay, extending from Fisherman's Bend (immediately east of the Broome township) to south of Sandy Point. It is described as a tropical marine embayment with extensive, highly biologically diverse, intertidal mudflats, which is internationally important for at least 20 species of migratory shorebirds; it is one of the most important sites for shorebird conservation in the East Asian-Australian Flyway (DEH 2008).

Roebuck Bay is also listed under the Directory of Important Wetlands in Australia (DEH 2008) (WA020). The limits to this site are Entrance Point in the north-west, and Cape Villaret in the south-west. No threatened flora species are known from the site.

2. Methods

Floristic Community Type (FCT) mapping was undertaken throughout the survey area. This method utilises recording of data from standard-sized quadrats distributed throughout the survey area, with the presence/absence of flora species being analysed by a computer based statistical analysis program (PATN) to determine floristic relationships between quadrats. The groupings are then verified against field data and FCT descriptions determined from final groupings of quadrats. Boundaries of FCTs within the survey area have also been mapped using a combination of aerial photography of the survey area, descriptions of FCTs, topography and locations of quadrats. The method of analysis of FCTs is currently being undertaken by the DEC over a variety of projects in the State, including vegetation surveys of Banded Ironstone Formations (BIF) in the Mid-West (Markey and Dillon 2006).

This survey undertook to describe and map FCTs throughout the survey area. The survey area was determined to include the Port of Broome-managed lands, and areas of intact vegetation in UCL further north in the Broome Peninsula, to determine the extent of FCTs within the Peninsula. Three detailed recording sites were also surveyed. These were undertaken in areas where the vegetation was very narrow, and therefore the quadrat size used (20m x 20m) would not fit (particularly in coastal areas). Also, in one area the establishment of quadrats would disturb local people that were at the time camping in the area.

A Level 2 Survey, as defined by the Environmental Protection Authority (2004), was determined to be the appropriate level of survey for this project as the scale and nature of the

impact is likely to have 'high' and 'moderate' characteristics (EPA 2004; Appendix 2; Table 3) and the survey area is within a Group 3 bioregion (Dampierland Bioregion).

A Level 2 survey consists of either a detailed or comprehensive survey. The purpose of a comprehensive survey is to enhance the level of knowledge at the locality scale, and the context in the local scale. A comprehensive survey involves one or more visit/s in the main flowering season and visit/s in other seasons; replication of plots in vegetation units, and greater coverage of plots over the target area (in comparison to a Level 1 survey), over the locality and part of the local area. Multiple visits are also required (EPA 2004).

2.1 Collecting Licenses

All plant material was collected under the following licenses:

Personnel	DRF Collecting Permit	Flora Collecting Permit
Catherine Godden	162 – 06/07	SL00 7778
Bianca Taylor	165 – 06/07	SL00 7678
Kylie Greenacre	78-0708	SL00 8064
Brendan Stratton		SL00 8068
Greg Woodman	75-0708	SL00 8043

No Regulation 4 permits were required as part of this survey.

2.2 Field Survey

The original field survey was conducted by Catherine Godden and Bianca Taylor from 27th – 31st August 2007, with a second field survey conducted by Greg Woodman, Bianca Taylor, Kylie Greenacre and Brendan Stratton from 7th – 11th April 2008. Assistance was provided in the field by Mr. Neil McKenzie. A series of 31 quadrats, each measuring 20m x 20m, were established throughout the survey area. All corners to each of the plots were marked using steel fence droppers during the survey, with only one corner left in for perpetuity (Appendix C). Figures 3a – 3e present the locations of quadrats established during this survey.

All species that were collectable and identifiable within each quadrat were recorded, and collected as necessary. The following information was recorded at each quadrat:

- Personnel;
- Date of survey;
- Location (GDA94);
- Photograph;
- Topography;
- Soil type and soil colour;
- Vegetation condition (Scale – see Government of Western Australia 2000);
- Approximate time since fire;
- Percentage foliage cover (for each species); and
- Height (m) (for each species, excluding climbers).

A total of 3 detailed recording sites were also undertaken during the survey. As described under Section 2. (Methods), these were undertaken in areas where the plant community was either too narrow to permit the establishment of a 20m x 20m quadrat, or the establishment of such would impact negatively upon local people in the area. Although the same data as described above was recorded, as the site area was not a standard 20m x 20m area (detailed site recording measures plant species within approximately a 10m radius of the centre point instead), this data has not been used during statistical analysis.

During the April 2008 survey, all quadrats established in August 2007 were re-visited for further searching, specifically annual species which are only present during and at the end of the wet season. An additional quadrat was established in one location to further develop the understanding of this particular community type. As a result of this second survey it is thought that approximately 80% of the flora of the study area were identified.

Two proposed development areas with the potential to contain the DRF species *Keraudrenia exastia* were searched for significant flora (including DRF and priority species), with an emphasis placed on the locating and counting of *Keraudrenia exastia* individuals. These entire areas were walked in transects 20m apart, with each individual significant flora location and population number recorded.

In addition to the above targetted searching, all areas within the project area were searched opportunistically for significant flora locations.

Neil McKenzie, an elder of the Yawuru tribe, kindly provided information regarding local Aboriginal usage of plant species in terms of food, medicine and other cultural aspects during our field studies. All information volunteered by Mr McKenzie regarding native flora was recorded and is presented in this report.

2.3 Plant Collection and Identification

Specimens were collected for identification at the WAHerb where flora species unknown to the surveyors were encountered during the survey. The locations of all DRF, Priority flora and other species of interest observed were noted. All plant identifications were undertaken by Lorraine Cobb and Sharyna Thomson; with assistance from experts in the relative fields of taxonomy, including Malcolm Trudgen.

Plant species nomenclature used in this report follows Packowska and Chapman (2000). All names were checked using the Max Database to ensure their validity. The conservation status of all species collected was checked using the current Department of Environment and Conservation list (DEC 2008a).

Specimens of species of interest (Priority Flora species, range extensions and those that are potentially new species) will be submitted to the WAHerb for inclusion into the collections at the end of this project. Rare Flora Report Forms (RFRF) will be submitted for locations of Priority Flora species recorded within detailed sites, quadrats, and for opportunistic recordings for species that were not collected in sites or quadrats.

2.4 Statistical Analysis

Statistical analysis and determination of FCTs were conducted using quadrat data only. Statistical analysis of the quadrat derived data was conducted using methods similar to those used by Markey and Dillon (2006). In the DEC studies quadrat data was analysed statistically using three separate statistical packages and following a method utilised in previous regional floristic surveys (Gibson 2004 and references therein).

Classification and ordination analyses were conducted on a data matrix compiled from the quadrat data, with introduced, annual and singleton (taxa occurring once in the dataset) taxa omitted prior to analysis. Various taxa were grouped together within the data matrix for the analyses where taxonomy was unclear or where different infra-taxa were identified within the dataset and not correlated to community type.

Pattern analysis was conducted using PATN (V3.03) (Belbin 1989). The Bray-Curtis coefficient was used to generate an association matrix for classification and ordination analyses. Within PATN the agglomerative hierarchical clustering method using flexible UPGMA (ß=-0.1) was used to generate a species by site classification (Sneath and Sokal 1973) and two way tables.

Indicator species analysis (INDVAL) was conducted using PC-Ord (McCune and Mefford 1999) using the method of Dufrene and Legendre (1997). The INDVAL measures were used to determine the indicator species for each FCT and a Monte Carlo permutation test was used to test for the significance of the indicator species.

2.5 Boundary Mapping

Boundary mapping of FCTs was undertaken after statistical analysis of quadrat data, and interpretation of aerial photograhy at a scale of 1:10 000, in relation to location of quadrats, and topographical data.

3. Results

4.1 Flora

A total of 167 discrete vascular plant taxa, from 113 genera and 53 families, were recorded during the surveys conducted in August 2007 and April 2008. The most well-represented families were Poaceae (23 taxa, including 3 introduced taxa), Papilionaceae (16 taxa, including 2 introduced taxa), Mimosaceae (9 taxa), Malvaceae (8 taxa, including 1 introduced taxa) and Myrtaceae (7 taxa). Appendix D presents a list of vascular plant taxa recorded during the survey.

4.1.1 Conservation Significant Species

Five conservation significant flora species were recorded during the surveys in August 2007 and April 2008. The locations of these are presented in Table 8, and on Figures 3a – 3e.

One location of *Keraudrenia exastia* (DRF) was recorded during the survey, near but just outside of the location known as Population 'C' (Broome Botanical Society Inc. 1995), and Population '2' (Urbanplan 2006). This was located at quadrat POB-03 (Appendix C; Figure 3a). Individuals of this species in this area looked healthy, however there has been some general previous disturbance in this area. Appendix G presents a photograph of *Keraudrenia exastia* (Plate 1).

During the survey in April 2008, individuals of *Keraudrenia exastia* known in Population 'C' were located and counted using methods described in Section 2.2. Approximately 21,000 individual plants were recorded in this area and these locations are shown on Figures 2 and 3a.

Goodenia byrnesii is a small herb which grows in sand and on the edges of creeks, usually flowering from January – February. The distribution of this priority 1 species is restricted to the Northern Botanical Province, mostly near Broome and to the north of Halls Creek (DEC 2008c). This species was recorded in 7 of the 31 quadrats established during the survey (Figures 3a-e), and also at various locations throughout the survey area. Woodman Environmental also recorded *Goodenia byrnesii* in 1 location near Derby during a survey in 2007 (Woodman Environmental 2007c).

The Priority 3 species *Triodia acutispicula* was recorded in 17 of the 31 quadrats established during the survey (Figures 3a-e). The percentage foliage cover for this species ranged from 1% – 60%, and it was usually a co-dominant of hummock grassland stratum with *Triodia pungens*, or more rarely *Triodia microstachya*.

Triodia acutispicula is a tussock-forming resinous perennial grass, growing to a height of 1.5m, and usually flowers from January – April. It has a relatively wide distribution, including the Drysdale River, Cape Leveque, Derby, Prince Regent River, Beverley Springs Station and Mitchell Plateau (DEC 2008c). This species was recorded at several locations by Woodman Environmental near Stokes Bay and between Derby and Fitzroy Crossing (Woodman Environmental 2007a-c). This species has been shown to be relatively common in the Kimberley region of WA and should be reviewed by the DEC for removal from the Priority Flora list.

Phyllanthus aridus, a Priority 3 species, is a small shrub growing to 0.25m high on sandstone, gravel and red sand. The distribution of this species in Western Australia ranges from Halls Creek to Karratha (DEC 2008c), with Woodman Environmental Consulting previously recording several locations between Broome and Port Headland in 2007 (Woodman Environmental 2007e). *Phyllanthus aridus* was recorded in one location in the Broome survey area, which was in FCT 4 and is shown in Figure 3a.

A potentially new taxa, *Scleria* sp., was recorded in two quadrats (POB-03 and POB-16) during the survey (Table 8; Appendix C) and at various other locations throughout the study area (Figures 3a to 3e). The percentage foliage cover of this species at each of these locations was very small, at 0.1% cover, and the height of this species ranges from between 0.3m – 0.4m. The vegetation at quadrat POB-03 was dominated by an open woodland of *Corymbia dampieri*, *Corymbia paractia* and *Erythrophleum chlorostachys* over an open shrubland dominated by *Acacia tumida* var. *tumida* and *Acacia colei* var. *colei* over *Acacia adoxa* var.

subglabra over a grassland of *Triodia pungens*, *Aristida holathera* ?var. *holathera* and *Triodia acutispicula*. The vegetation at quadrat POB-16 was dominated by an open woodland of *Corymbia dampieri* with *Bauhinia cunninghamii*, over a shrub layer dominated by *Acacia colei* var. *colei*, *Acacia eriopoda* and *Psydrax attenuata* var. *tenella* over a hummock grassland dominated by *Triodia acutispicula*.

This potentially new taxa was also recorded by Woodman Environmental during a survey for Arc Energy near Stokes Bay in 2007 (Woodman Environmental 2007a). This species was recorded in plant community 'S1: Shrubland of *Acacia tumida* var. *tumida* over Dense Grassland of *Chrysopogon fallax* and *Triodia acutispicula* with occasional mixed shrub species on red-brown sands on midslopes', and was located close to an existing access track from Point Torment Road. Four *Scleria* species are known from the Dampierland and Central Kimberley Regions, 3 of which occur only in damp areas and along watercourses (DEC 2008c). This potentially new species has a larger, hairy nut which is not known from other *Scleria* species.

Table 8: Location of Significant Flora Species Recorded during the Surveys, August 2007 and April 2008

Species	Conservation Status	Quadrats Recorded	Floristic Community Type(s) (Section 4.2)
Keraudrenia exastia	DRF	POB-03	FCT 4
Goodenia byrnesii	P1	POB-04, POB-09, POB-14, POB-17, POB-23, POB-26, POB-27	FCT 4; FCT 5
Triodia acutispicula	P3	POB-03; POB-04; POB-05; POB-06; POB-08; POB-09; POB-10; POB-11; POB-12; POB-13; POB-14; POB-15; POB-16; POB-17; POB-24; POB-25; POB-26	FCT 1; FCT 2; FCT 4; FCT 5
Phyllanthus aridus	P3	North of POB-05 at GPS location (GDA94, Zone 51): 415001, 8010841	FCT 4
Scleria sp.	-	POB-03; POB-16	FCT 4; FCT 5

Three species were recorded as range extensions; *Panicum effusum*, *Amaranthus mitchellii*, and **Ziziphus mauritania*. *Panicum effusum* is known from areas near Halls Creek and Newman but has not previously been recorded near Broome, whilst *Amaranthus mitchellii* has been recorded near Karratha and many other areas in the Eremaean botanical province (DEC 2008c). In 2007 Woodman Environmental recorded this species approximately 110km north east of Marble Bar (Woodman Environmental 2007d), making the latest recording a range extension to the north east of approximately 320km. **Ziziphus mauritania*, an introduced species was recorded at quadrat POB-29 (Appendix C). See Section 4.1.2 for more information regarding this species.

4.1.2 Introduced Species

A total of 14 introduced (weed) species were recorded during the survey. These species and their recording locations are shown in Table 9, and their species names are also listed in

Appendix D, denoted with a * prior to the species. Two of these species are listed as Declared Plants under the *Department of Agriculture and Related Resources Act 1976* (Department of Agriculture and Food 2008). Declared Plants are subject to standard control codes throughout the State, which are described in Appendix E.

Table 9: Location of Introduced Flora Species Recorded during the Surveys, August 2007 and April 2008

Species	Quadrats Recorded	Opportunistic GPS locations*	Floristic Community Type(s) (Section 4.2)
Aerva javanica	POB-01, POB-20	415621, 8009817 415988, 8009693 415966, 8009655	FCT 1, FCT 3
Cenchrus ciliaris	POB-02, POB-20, POB-22	415662, 8007849 415988, 8009693	FCT 3
Chloris barbata	POB-20	-	FCT 3
Clitoria ternatea	POB-19, POB-20	-	FCT 1, FCT 3
Emilia sonchifolia	POB-20	-	FCT 3
Hyptis suaveolens	POB-20	-	FCT 3
Jatropha gossypifolia	POB-22, POB-30	-	FCT 3, FCT 5
Macroptilium atropurpureum	POB-20	-	FCT 3
Merremia dissecta	POB-04, POB-22	414882, 8009805	FCT 3, FCT 4
Passiflora foetida var. *hispida*	POB-01, POB-03, POB-04, POB-07, POB-10, POB-11, POB-12, POB-20, POB-22, POB-24, POB-25, POB-27	POB Site 02	FCT 1, FCT 2, FCT 3, FCT 4, FCT 5, FCT 6
Setaria verticillata	POB-03	-	FCT 4
Sida cordifolia	POB-10	416108, 8010666	FCT 2
Tridax procumbens	-	415697, 8009706	FCT 4
Ziziphus mauritiana	POB-29	-	FCT 1

*Note: All GPS locations are GDA94, Zone 51.

Jatropha gossypifolia (Bellyache Bush) is an erect shrub or small tree to approximately 4m high, and is originally a native of tropical Central and South America, and the Caribbean. It is deciduous in dry conditions. The leaves are sticky, and palmate in three segments. Flowers appear from February to May. This species is a weed of grazed woodlands, creeklines and wasteland in the Kimberley Region (Hussey *et. al.* 1997). This species is listed as Control Code P1 (for the whole of the State), and category P4 for the Broome Shire (Appendix E). This species was recorded at quadrats POB-22 and POB-30 (Appendix C).

Ziziphus mauritiana (Chinese date, Indian jujube) is a thorny spreading tree native to Asia, growing to 6m with a canopy of up to 10m wide. The stems have large thorn, and the flowers are green and inconspicuous. The fruit is edible, with a woody stone covered with white flesh. This species is naturalised around Broome and Derby (Hussey *et. al.* 1997). This species is listed as Control Code P1 and P2 for the Broome Shire. This species was recorded at quadrat POB-29 (Appendix C).

Two other weed species recorded during the survey are highly invasive species, including *Cenchrus ciliaris* (Buffel Grass) and *Aerva javanica* (Kapok bush). These species will invade native bushland from established populations within disturbed areas and it is recommended that populations of these species are also controlled on Broome Port Authority-managed lands. *Cenchrus ciliaris* was recorded at quadrats POB-02, POB020 and POB-22; *Aerva javanica* was recorded at quadrats POB-01 and POB-20 (Appendix C); however both species are fairly widespread, especially near disturbed areas.

Other weed species recorded during the survey, including *Chloris barbata* (purpletop chloris), *Setaria verticillata* (whorled pigeon grass), *Clitorea ternata* (butterfly pea), *Macroptilium atropurpureum* (siratro), *Passiflora foetida* var. *hispida* (stinking passion flower), *Merremia dissecta*, *Hyptis suaveolens* (hyptis, mintweed) and *Emilia sonchifolia* (red tassel flower), *Setaria verticillata* (whorled pigeon grass), *Sida cordifolia* (sida), *Tridax procumbens* (tridax) are widespread through the tropics and/or Kimberley region (Hussey *et. al.* 1997).

4.1.3 Notes on Indigenous Use of Plant Species in Survey Area

Mr. Neil McKenzie provided information regarding a range of food, medicinal and cultural uses for plant species encountered during the survey. These are described in Table 10. This listing is by no means exhaustive. For further information a comprehensive range of information is presented in Kenneally *et. al.* (1996).

Traditional uses of plant species as per Table 10 are of the Yawuru people. Appendix G presents photos of some of these species.

Table 10: Indigineous Uses of Plant Species Recorded during the field surveys, August 2007			
Common Name	**Family**	**Plant Taxa**	**Traditional Uses**
Conkerberry	Apocynaceae	*Carissa lanceolata*	Ceremonial wood; Edible fruits sweet when ripe (black berries)
Bush Banana	Asclepiadaceae	*Marsdenia viridiflora* subsp. *tropica*	Young fruit eaten
Mother-in-law tree; Jigal Tree; Kimberley Bauhinia	Caesalpiniaceae	*Bauhinia cunninghamii*	Use of nectar from flowers in drink, with a similar effect to Red-Bull
Gubinge	Combretaceae	*Terminalia ferdinandiana*	Edible berries with a very high Vitamin C content; edible sap (roast hard sap and chew); edible seed kernal; mix fruit with hot water to make a drink; bark infused in tea (turns purple) for medicinal use - dries up cuts, sores, etc on skin
Marool; Blackberry Tree	Combretaceae	*Terminalia petiolaris*	Edible fruits with a high level of Vitamin C
Helicopter Tree; Coolaman Tree; Gold and Silver Tree	Gyrostemonaceae	*Gyrocarpus americanus* subsp. *pachyphyllus*	Bark used for shields and coolamans (carriers); bark also used to treat prickly rash, with the charcoal acting as an anti-histimine
Firestick Tree	Lamiaceae	*Premna acuminata*	Wood used in making spears and fire sticks; used in making of fire; use in ornamental traditional dress
Yugulu	Lauraceae	*Cassytha filiformis*	Use of dense tangled stems in fishing nets; use of tangled stems into making footwear; edible seeds
Yellow Ball Flower	Menispermaceae	*Mallotus nesophilus*	Edible fruits
Snake Vine	Menispermaceae	*Tinospora smilacina*	Used in ceremony to stop rain
Dune Wattle	Mimosaceae	*Acacia bivenosa*	Grinding of seeds to make biscuits
Sandpaper Fig	Moraceae	*Ficus aculeata* var. *orbicularis* ms	Stimulates milk production; scraping of skin with leaves helps eczema and ringworm
Bloodwood	Myrtaceae	*Corymbia* spp.	Medicinal antiseptic sap for toothache; bloodwood 'apples' for food; sugary gum from insects for candy; firewood
Crabs Eye Bean	Papilionaceae	*Abrus precatorius* subsp. *precatorius*	Seeds are very poisonous
Green Birdflower	Papilionaceae	*Crotalaria cunninghamii* subsp. *cunninghamii*	Edible nectar; base of flower tastes like snowpea; when dead trunks have grubs inside base for eating
Flinders river poison	Papilionaceae	*Tephrosia rosea* var. *rosea*	Use as a fish poison - smash roots, mix with sand, then put in rock pools and the poison coats gills of fish
Gummy Spinifex	Poaceae	*Triodia pugens*	Protection from insects; use in making of thatch for shelter and shade

Table 10: Indigineous Uses of Plant Species Recorded during the field surveys, August 2007			
Common Name	**Family**	**Plant Taxa**	**Traditional Uses**
Caustic Tree	Proteaceae	*Grevillea pyramidalis* subsp. *pyramidalis*	Paint used in ceremonies (turns white when applied); resin of seed pods is caustic and can burn
	Proteaceae	*Hakea macrocarpa*	Use of charcoal during ceremonies
Geebung	Proteaceae	*Persoonia falcata*	Sweet seeds ground into a paste and made into a pudding; do not eat flowers
Supplejack	Rhamnaceae	*Ventilago viminalis*	Medicine bark, used as an infusion and applied to deep cuts, sores and swellings; use in manufacture of boomerangs
Tropical Sandalwood	Santalaceae	*Santalum lanceolatum*	Bark burnt to heal cuts and sores and repel mosquitoes; edible soft flesh around seed

4.2 Vegetation

Analysis of the PATN generated dendogram identified 2 super-groups with the initial dissection occurring at the group 6 level. The two super-groups reflect the two broad landscape types of the survey area – coastal dunes and pindan soils.

Super-group 1: Open Woodlands and Shrublands over grasslands on pale brown to orange sands on foredunes, immediately behind foredunes and other dunal areas

A total of 37 plant taxa were recorded within quadrats grouped into super-group 1 that were not recorded in super-group 2 (Appendix F).

Super-group 2: Open Woodlands over Shrublands over grasslands on orange to red pindan soils on lowerslopes to crests

A total of 73 plant taxa were recorded within quadrats grouped into super-group 2 that were not recorded in super-group1 (Appendix F).

4.2.1 Floristic Community Types

A total of 6 FCTs are described within the survey area, as a result of statistical analysis from quadrat data collected in August 2007 and April 2008. An additional 2 FCTs are disturbed variants of 2 main FCTs and are also described within the survey area in small patches. A total of 172 plant taxa were recorded within quadrats, with a listing of each of these plant taxa located within quadrats within each FCT presented in Appendix F. Of these taxa, a total of 102 taxa were used to define FCTs during the statistical analysis. Appendix C presents the FCT to which each quadrat was grouped.

Appendix H presents a summary dendrogram of the floristic relationships between each of the quadrats established in August 2007 and April 2008.

Appendix I presents a two-way table of plant taxa used during the statistical analysis, with recordings of taxa against individual quadrats within each FCT grouping. This details groups of plant taxa which are related within each FCT, which have been split into groups A-K (Appendix I). Generally, super-group 1 is most-represented by species from groups A, B and C, whereas super-group 2 is most-represented by species from groups E-K (Appendix I).

Indicator species resulting from the INDVAL measures and Monte Carlo permutation test are presented in Appendix J. Please note that as FCT 2 and FCT 6 contained only one quadrat each (POB-10 and POB 31 respectively), no indicator species are available for these FCTs.

Super-group 1

FCT 1: Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes

FCT 1 was represented by six quadrats, all located on the crests of foredunes or on the leeward side of the foredune, on the western coastline of the survey area, north of Gantheaume Point along Cable Beach (Figures 3a-3e). A single site was also conducted in this area (Figure 3d). A total of 52 native plant taxa were recorded within quadrats within this FCT (Appendix F). FCT 1 is most-represented by species from group C, with no representation of groups E, F or J (Appendix I). The average species richness of FCT 1 was 18.17 +- 6.34 taxa.

Indicator species for this FCT included *Acacia bivenosa*, *Boerhavia gardneri*, *Canavalia rosea*, *Crotalaria cunninghamii* subsp. c*unninghamii*, *Malotis nesophilus*, *Myoporum monatum*, and *Spinifex longifolius* (Appendix J). All of these species are coastal species, with *Spinifex longifolius* occurring on coastal sand dunes within Western Australia from the Kimberley region southwards to Cape Leeuwin. *Acacia bivenosa* is common in calcareous sand near Willie Creek and Cable Beach. Occurs south to Exmouth and also in the Northern Territory and Queensland. *Boerhavia gardneri* has been recorded as common in pindan near Broome, Gallen Well and One Arm Point. *Canavalia rosea* occurs in Western Australia on coastal beaches and sand dunes among limestone rocks, along the coast in and between the Northern Kimberley and Canarvon regions. *Crotalaria cunninghamii* subsp. c*unninghamii* is located on sand dunes and coastal dunes in the Victoria Bonaparte region along the coast south into the Dampierland region (DEC 2008c). *Malotis nesophilus* is found commonly in near coastal areas on the peninsula, predominantly on the leeward side of coastal sand dunes. *Myoporum monatum* is common in coastal pindan and vine thickets near Broome.

FCT 2: Open Woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and Poaceae sp. 2 on orange sand on secondary dunes

FCT 2 was represented by one quadrat only (POB-10), located on secondary dunes on the sheltered eastern side of the southern Broome Peninsula, on Roebuck Bay. One site was also undertaken within this area (Figures 3a and 3c). A total of 25 native plant taxa were recorded within the quadrat established in FCT 2, including the P3 species *Triodia acutispicula* (Appendix F).

Although FCT 2 is grouped into super-group 1 with other coastal quadrats, this FCT is the least floristically-related of the group (Appendix H). *Corymbia polycarpa* was also recorded in FCT 5, which along with FCT 4 and FCT 6 form super-group 2. FCT 2 however did include species from group C, which were more typically recorded in super-group 1 (Appendix I). The only species recorded in FCT 2 and in no other FCT was *Cyperus conicus*, which Kenneally *et. al*. (1996) notes as occurring in pindan at Broome.

FCT 3: Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia petiolaris* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlanii* and *Abrus precatorius* subsp. *precatorius* on pale orange to brown sand on lowerslopes behind dunes, and secondary dunes

FCT 3 was represented by three plots, one in a disturbed area at the very southern end of the survey area (POB-02), and two on the western coast along Cable Beach (POB-20) and (POB-22) (Figures 3a-3e), which were located within a vine thicket. A total of 57 plant taxa, including ten introduced taxa, were recorded within FCT 3 (Appendix F). The average species richness of FCT 3 was 26.33 +- 0.6 taxa. This FCT equates to the TEC 67 (Monsoon Thickets).

FCT 3 is most represented by group A, with no representation from groups D-G and J (Appendix I).

Carissa lanceolata, Cassytha capillaris, Exocarpos latifolius, Grewia brevifolia, and *Tephrosia remotiflora* are the main indicator species for FCT 3 (Appendix J). *Exocarpos latifolius* is restricted to sandstone gullies, sand dunes and river banks in the Northern botanical province of Western Australia, whilst *Tephrosia remotiflora* occurs on pindan and sand dunes in the Northern botanical province, as well as inland in the Pilbara region (DEC 2008c). *Carissa lanceolata* is a tree of the pindan on the peninsula and is also known from the Northern Territory, while *Cassytha capillaris* is a parasitic twiner known from WA, NT, QLD, New Guinea, Indonesia and Sri Lanka. *Grewia breviflora* is known mainly from vine thicket communities on the Broome peninsula and the NT.

FCT3d: FCT 3d is a small area of disturbed FCT 3 vegetation, located at the very southern tip of the peninsula (Figure 3a). Clearing and developmental activities have led to the quality of the vegetation in this area to decline.

Super-group 2

FCT 4: Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions

FCT 4 was represented by 8 quadrats located on pindan soil on the southern half of the survey area (Figures 3a, 3b, 3e). A total of 90 plant taxa were recorded within quadrats in this FCT. This includes five conservation significant species, *Keraudrenia exastia* (DRF), *Goodenia byrnesii* (P1), *Triodia acutispicula* (P3), *Phyllanthus aridus* (P3) and the potentially new species, *Scleria* sp. (Appendix F). Four introduced species, *Merremia dissecta, Passiflora foetida* var. *hispida*, *Setaria verticillata* and *Tridax procumbens* were also recorded in FCT 4.

The average species richness of FCT 4 was 30.87 +- 6.00 taxa. Species in FCT 4 were most highly represented by group H, with scattered

representation in groups G and I, and negligible representation from other groups (Appendix I).

Indicator species for FCT 4 included *Cassytha filiformis*, *Erythrophleum chlorostachys*, *Gardenia pyriformis* subsp. *keartlandii*, *Goodenia armitiana*, *Gyrostemon tepperi*, *Hibiscus leptocladus*, *Persoonia falcata*, *Scaevola parvifolia* subsp. *parvifolia*, *Scleria* sp., *Sida* sp. B (Kimberley Flora (A.A. Mitchell 2745), *Triodia acutispicula*, *Triodia pungens*, *Waltheria indica* and *Zornia prostrata* var. *prostrata* (Appendix I).

FCT 5: Open Woodland of *Corymbia damperi* and *Corymbia zygophylla* over sparse Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula*, *Triodia microstachya* or *Triodia pungens* on orange to red pindan soils on lower to upperslope positions

FCT 5 was represented by 12 quadrats, with nine plots located on pindan soils north of Gantheaume Point (Figures 3b-3e), two east of Gantheaume Point in the centre of the survey area (POB-12 and POB-14), and one on the western edge of the survey area (POB-25). A total of 107 plant taxa were recorded in this FCT, including the conservation significant species *Goodenia byrnesii* (P1), *Triodia acutispicula* (P3) and the potential new species *Scleria* sp (Appendix F). Two introduced species, *Jatropha gossypifolia* and *Passiflora foetida* var. *hispida*, were recorded in this FCT.

The total species richness of FCT 5 was 27.17 +- 5.57 taxa. Species in FCT 6 were most-represented by species group H, with scattered representation from species group G and K, similar to FCT 4 and 5(Appendix I). However, there was some representation from groups A and E which were not recorded in FCT 4, indicating FCT 5 is much more floristically diverse than FCT 4.

The only three indicator species for this FCT were *Acacia colei* var. *colei*, *Acacia eriopoda* and *Psydrax attenuata* var. *tenella*.

FCT 6: Dense Low Heath of *Acacia tumida* var. *kulparn* over mixed shrubs including *Cassytha filiformis*, *Mukia maderaspatana* and *Pterocaulon sphacelatum* over Open Hummock Grassland of *Triodia pungens* and *Triodia schinzii* on red to brown pindan soils on rocky headland positions.

FCT 6 was represented by one quadrat (POB-31) located on coastal edge near James Price Point. Including the introduced species *Passiflora foetida* var. *hispida*, a total of 22 plant taxa were recorded in this FCT.

No indicator species were identified statistically for this FCT because it was represented by only a single quadrat. However a good indicator species for this FCT would be *Acacia tumida var. kulparn*, a windswept and low shrub found on pindan soil in the Northern Botanical Province and inland south in the Great Sandy Desert region. This species was only found associated with this FCT during the survey.

FCT 6d: FCT 6d is a disturbed area of FCT 6, located in a narrow strip between the coastal cliffs and Kavite Road from James Price Point to Gantheaume Point (Figure 3b). This area has a powerline running through it and activities

relating to this powerline, the Kavite Road and historical clearing at Gantheaume Point have resulted in the vegetation degenerating.

The vegetation of the project area displayed the effects of long term disturbance associated with proximity to development with introduced species common. However the condition of the vegetation was mainly in Very Good Condition (Government of Western Australia 2000), with the exceptions being the edges of tracks and developed areas where weeds such as *Cenchrus ciliaris* (Buffel Grass) and *Aerva javanica* (Kapok) were common.

5. Discussion

This study sampled flora of the southern Broome Peninsula over two occasions prior to and following seasonal rains. As a result a significant percentage of the flora of the study area were identified, however due to the large size of the study area and the time available to undertake the studies it would be desireable in future to sample the vegetation units identified during the survey to more fully describe their flora.

From this study it can be seen that the floristic groupings respond to a combination of soil type (pindan associations versus coastal dune sand associations), hydrology (dune crest associations versus vine thickets of the dune base) and climate factors (FCT 4 at the exposed southern end of the Peninsula on pindan soils versus FCT 5 on northern sections of the Peninsula on pindan soils).

5.1 Conservation Significant Flora

Five conservation significant flora species were recorded during the surveys in August 2007 and April 2008. Species recorded within the Port of Broome managed lands include:

Keraudrenia exastia (DRF)
Goodenia byrnesii (P1)
Triodia acutispicula (P3)
Scleria sp.

It is possible that *Phyllanthus aridus* (P3) is also present within FCT 4 within the Port of Broome managed lands although at low density.

All of these species with the exception of the *K. exastia* are new records for the Broome Peninsula. Also, these species were recorded commonly elsewhere within the broader study area on pindan soils and as such any proposed developments within the Port of Broome lands would not have significant impacts on the conservation status of each.

This study identified new locations of *K. exastia* plants in the vicinity of existing populations, however no new populations were recorded during 2007 and 2008. All plants appeared to be in good health and all populations were in flower with the exception of the north-western most population which appeared to be sterile. The condition of vegetation surrounding the *K. exastia* populations appeared to be only Good as a result of previous disturbance and altered fire regimes resulting in a dominance of *Acacia* species and dense covers of *Cassytha filiformis*. Research is

required into the ecology and propagation of *K. exastia* to identify mechanisms for protection of the existing populations and also to identify management strategies that will promote the long term sustainability of the species.

5.2 Conservation Significant Vegetation

This study has identified several floristic community types of conservation significance. FCT 3, which is representative of TEC 67 (Monsoon Thickets) is located on the inland side of coastal dunes along the Dampier Peninsula, and tend to become larger and have greater species diversity in a northwards direction. Near Broome distinctive components of this community include *Pouteria sericea*, *Exocarpos latifolius*, *Grewia breviflora*, *Grewia retusifolia*, *Pavetta kimberleyana*, *Bridelia tomentosa*, *Premna acuminata*, *Terminalia petiolaris* and *Terminalia ferdinandiana*. No intact areas of this FCT are located within the Port of Broome managed lands, though areas near the southern tip of the peninsula may have been representative of this FCT in the past prior to the severe disturbance associated with the Port and related activities since settlement.

The PEC 11 Kimberley (*Corymbia paractia* dominated community on dunes) is reportedly common between Gantheaume Point and Cable Beach, however it is apparently restricted to a narrow coastal zone in the Broome area where beach dunes merge into pindan soils (Kenneally *et. al.* 1996), and is often found mixed with rainforest (monsoon) species (Kevin Kenneally and Val English *pers. comm*). This community is likely to be either a subset of the TEC 67 community or to occur as a mosaic within it. This community could not be identified as a separate entity during this study and as such has not been mapped. This community is not located within the Port of Broome managed lands.

PEC 10 Kimberley (Dwarf pindan heath community of Broome coast). This community was described by Trudgen (1988) as 'AtGp' on pindan soils (Table 3), and is a reference to *Acacia tumida* var. *kulpan*, which occurs on coastal cliffs at Gantheaume Point and James Price Point as a wind pruned shrub to 50cm in height (Kevin Kenneally and Val English, *pers. comm*.). This vegetation type is discussed in Broome Botanical Society Inc. (1995), where it is located on the near-coastal hinterland from Gantheaume Point past Riddell Beach towards the Port of Broome. PEC 10's characteristics include low-profile wind-sheared shrubs, small areas of almost monotypic spinifex grasslands and traces of residual Pleistocene linear dunes. This community was mapped as FCT 6 and is not located within the Port of Broome managed lands.

FCT 4 Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions. This FCT is likely to be restricted to the southern end of the Broome Peninsula as it potentially occurs as a result of the unique climate of this area, being surrounded in close proximity on 3 sides by the Indian Ocean and Roebuck Bay. This has also been reported by Malcolm Trudgeon in his survey of the Broome Peninsula. Additional clearing of this FCT within the Port of Broome managed lands should concentrate on areas of degraded vegetation and be offset by areas of this community in Good condition or better being preserved within a reserve system.

5.3 Port of Broome Proposed Developments

The Port of Broome currently proposes to develop two additional areas within its currently managed lands totalling approximately 30 ha. The Port has also made commitments to relinquish approximately 44 ha of remnant vegetation including areas of FCTs 1, 2 3d and 4 into the existing Minyirr Park Reserve. This land would provide linkage along the coast to the southern tip of the peninsula and also a corridor across the peninsula in the vicinity of the current alignment of Kavite Road to connect the western side of the peninsula to the easten shore. The Port has also committed to the rehabilitation of Kavite Road on its lands west of the current limit of development.

Surveys within areas of proposed development identified and mapped the flora species of conservation significance listed in section 5.1. The location of *K. exastia* plants within a portion of this area should be avoided and proposed development boundaries amended in accordance with recommendations in the following section.

The currently proposed vegetated corridor would provide valuable linkage and habitat on the peninsula, however the currently proposed east to west linkage contains a very narrow section adjacent to the stockyards. This section contains quite degraded vegetation and the narrow width in combination with the existing Port Road alignment limits the potential of this area to act as a true linkage for fauna species. The inclusion of additional vegetation to increase the linkage width in this area in combination with the development and implementation of an environmental management programme that addresses weed management and rehabilitation of disturbed areas within the proposed corridors would provide the potential to significantly improve the quality of the vegetation and habitats on the southern end of the peninsula.

The proposed involvement of the Port of Broome with the future of the traditionally managed Minyirr Park and the ongoing consultation and involvement of the traditional owners with the Authority regarding future developments and management of the peninsula will ensure that traditional uses of the peninsula are not significantly impacted by Port of Broome operations.

6. Recommendations

The following recommendations are given:

Keraudrenia exastia

- Areas of proposed development should be re-designed to avoid all locations of this species, preferably leaving a buffer of approximately 50m.
- Conditions should be placed on all developments in the vicinity of this species to ensure the plants are protected from direct and indirect impacts such as dust and drainage from industrial sites.
- The populations of this species should be monitored every 3 years.
- The Port of Broome should liaise with the Broome Botanical Society and the Department of Environment and Conservation regarding the preservation of this species with the objective of identifying and funding appropriate research on the

ecology and propagation strategies of the species. The results of this research to be used as part of a management/recovery plan for the species on the Broome Peninsula.

Port of Broome Environmental Management Programme

- An Environmental Management Plan (EMP) should be developed to address the on-going management of the Environmental Cultural Corridor and the remaining vegetation of the Port of Broome managed lands. This document should include sections on weed management, fire management, drainage, cultural aspects and monitoring. An outline for this EMP is provided in Appendix L.

7. Acknowledgements

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8017500mN

415000mE

417500mE

8015000mN

8012500mN

8010000mN

0 400m
Scale
MGA94 (Zone 51)

LEGEND

Limit of Broome Port Authority Survey Area

Boundary of Broome Port Authority Managed Lands

Broome Port Authority
P.O. Box 46, Broome WA 6725
Tel 9192 1304, Fax 9192 1778

FLORISTIC COMMUNITY TYPE SURVEY AREA

woodmanenvironmentalconsulting
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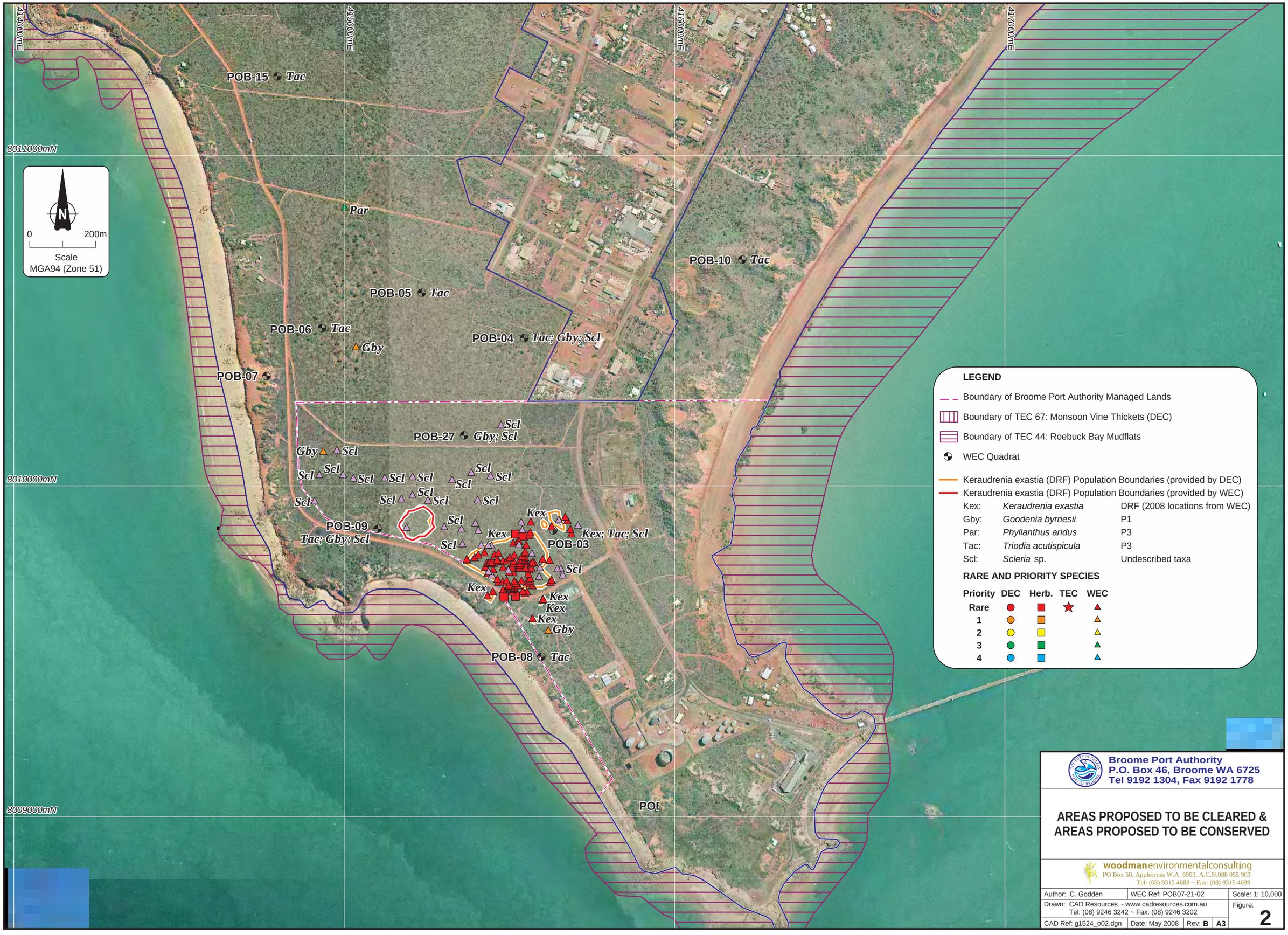
Tel: (08) 9315 4688 ~ Fax: (08) 9315 4699

Author: C. Godden	WEC Ref: POB07-21-02	Scale: 1: 25,000
Drawn: CAD Resources ~ www.cadresources.com.au Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202		Figure: 1
CAD Ref: g1524_o01.dgn	Date: May 2008	Rev: B A3



Broome Port Authority
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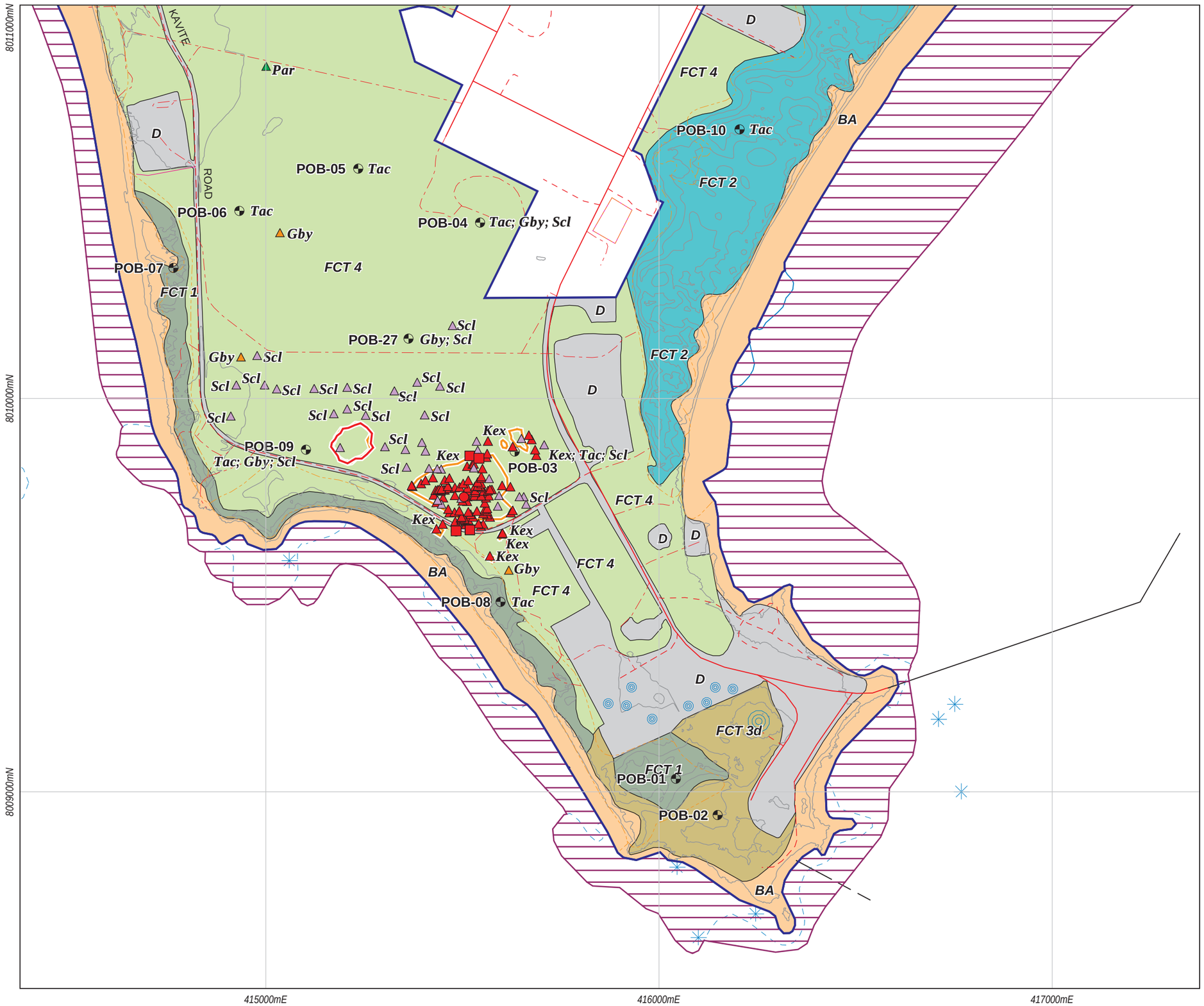
AREAS PROPOSED TO BE CLEARED & AREAS PROPOSED TO BE CONSERVED

woodmanenvironmentalconsulting
PO Box 50, Applecross W.A. 6953, A.C.N.088 055 903
Tel: (08) 9315 4688 ~ Fax: (08) 9315 4699

Author: C. Godden	WEC Ref: POB07-21-02	Scale: 1: 10,000
Drawn: CAD Resources ~ www.cadresources.com.au Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202		Figure: 2
CAD Ref: g1524_o02.dgn	Date: May 2008	Rev: B A3



LEGEND

FCT 1 Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes

FCT 2 Open Woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and Poaceae sp. 2 on orange sand on secondary dunes

FCT 3 Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia petiolaris* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlanii* and *Abrus precatorius* subsp. *precatorius* on pale orange to brown sand on lowerslopes behind dunes, and secondary dunes

FCT 3d Disturbed areas of FCT 3

FCT4 Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions

FCT 5 Open Woodland of *Corymbia damperi* and *Corymbia zygophylla* over sparse Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula, Triodia microstachya* or *Triodia pungens* on orange to red pindan soils on lower to upperslope positions

FCT 6 Dense Low Heath of *Acacia tumida* var. *kulparn* over mixed shrubs including *Cassytha filiformis*, *Mukia maderaspatana* and *Pterocaulon sphacelatum* over Open Hummock Grassland of *Triodia pungens* and *Triodia schinzii* on red to brown pindan soils on rocky headlands

FCT 6d Disturbed areas of FCT 6

Other

BA Bare Areas

D Disturbed Areas

Quadrat
Detailed Recording Site

Conservation Significant Species

Kex:	*Keraudrenia exastia*	DRF (2008 locations from WEC)
Gby:	*Goodenia byrnesii*	P1
Par:	*Phyllanthus aridus*	P3
Tac:	*Triodia acutispicula*	P3
Scl:	*Scleria* sp.	Undescribed taxa

Limit of Broome Port Authority Survey Area

Keraudrenia exastia (DRF) Population Boundaries (provided by DEC)

Keraudrenia exastia (DRF) Population Boundaries (provided by WEC)

DEC TEC 67: Monsoon Vine Thickets

DEC TEC 44: Roebuck Bay Mudflats

RARE AND PRIORITY SPECIES

Priority	DEC	Herb.	TEC	WEC
Rare	●	■	★	▲
1	●	■		▲
2	●	■		▲
3	●	■		▲
4	●	■		▲

0 100 200m

Scale 1:10,000
MGA94 (Zone 51)

N

Sheet Locality

Broome Port Authority
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FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES AUGUST 2007

Sheet 1 of 5

woodmanenvironmentalconsulting
PO Box 50, Applecross W.A. 6953, A.C.N.088 055 903
Tel: (08) 9315 4688 ~ Fax: (08) 9315 4699

Author: C. Godden	WEC Ref: POB07-21-02	Scale: 1: 10,000
Drawn: CAD Resources ~ www.cadresources.com.au Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202		Figure: **3a**
CAD Ref: g1524_v01.dgn	Date: May 2008	Rev: **B** **A3**

413000mE
414000mE
415000mE
8013000mN
8012000mN
8011000mN

FCT 3
FCT 5
ROAD
POINT
BA
FCT 1
POB-18
GANTHEAUME
Scl
POB-16
Tac; Scl
Scl
Gby
Gby
POB-30
FCT 5
BA
FCT 4
D
POB-11
Tac
FCT 4
FCT 6d
racecourse
D
POB-13
Tac
POB-12
Tac
POB Site 1
POB-31
FCT 6
FCT 4
KAVITE
ROAD
FCT 5
POB-14
Tac; Gby
POB-15
Tac
FCT 4

LEGEND

FCT 1 Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes

FCT 2 Open Woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and Poaceae sp. 2 on orange sand on secondary dunes

FCT 3 Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia petiolaris* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlanii* and *Abrus precatorius* subsp. *precatorius* on pale orange to brown sand on lowerslopes behind dunes, and secondary dunes

FCT 3d Disturbed areas of FCT 3

FCT4 Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions

FCT 5 Open Woodland of *Corymbia damperi* and *Corymbia zygophylla* over sparse Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula, Triodia microstachya* or *Triodia pungens* on orange to red pindan soils on lower to upperslope positions

FCT 6 Dense Low Heath of *Acacia tumida* var. *kulparn* over mixed shrubs including *Cassytha filiformis*, *Mukia maderaspatana* and *Pterocaulon sphacelatum* over Open Hummock Grassland of *Triodia pungens* and *Triodia schinzii* on red to brown pindan soils on rocky headlands

FCT 6d Disturbed areas of FCT 6

Other

BA Bare Areas

D Disturbed Areas

Quadrat
Detailed Recording Site

Conservation Significant Species

Kex:	*Keraudrenia exastia*	DRF (2008 locations from WEC)
Gby:	*Goodenia byrnesii*	P1
Par:	*Phyllanthus aridus*	P3
Tac:	*Triodia acutispicula*	P3
Scl:	*Scleria* sp.	Undescribed taxa

Limit of Broome Port Authority Survey Area

Keraudrenia exastia (DRF) Population Boundaries (provided by DEC)

DEC TEC 67: Monsoon Vine Thickets

DEC TEC 44: Roebuck Bay Mudflats

RARE AND PRIORITY SPECIES

Priority	DEC	Herb.	TEC	WEC
Rare	●	■	★	▲
1	●	■		▲
2	●	■		▲
3	●	■		▲
4	●	■		▲

0 100 200m

Scale 1:10,000
MGA94 (Zone 51)

N

Sheet Locality

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FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES AUGUST 2007

Sheet 2 of 5

woodmanenvironmentalconsulting
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Author: C. Godden	WEC Ref: POB07-21-02	Scale: 1: 10,000
Drawn: CAD Resources ~ www.cadresources.com.au Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202		Figure: **3b**
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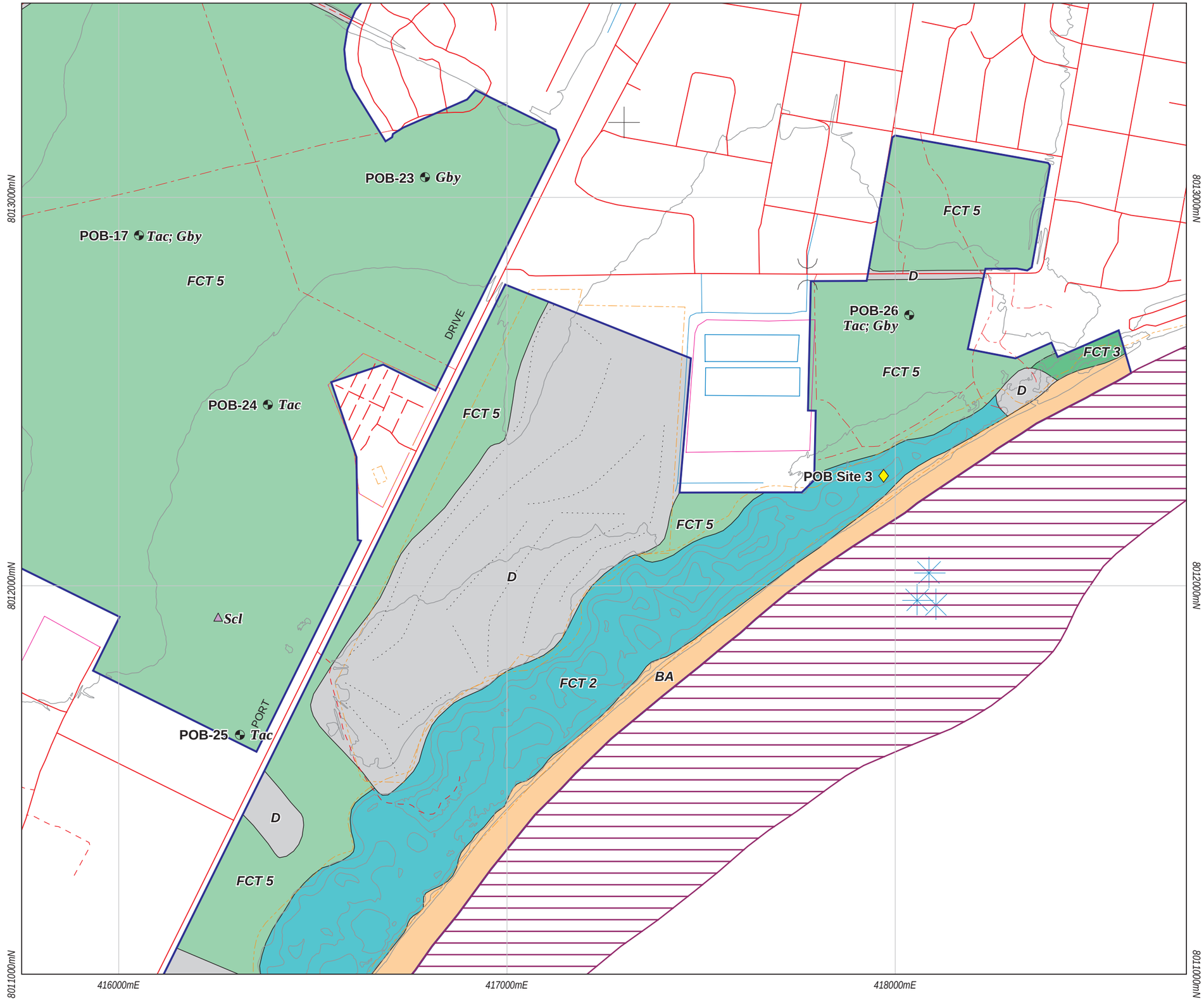

LEGEND

FCT 1 Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes

FCT 2 Open Woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and Poaceae sp. 2 on orange sand on secondary dunes

FCT 3 Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia petiolaris* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlanii* and *Abrus precatorius* subsp. *precatorius* on pale orange to brown sand on lowerslopes behind dunes, and secondary dunes

FCT 3d Disturbed areas of FCT 3

FCT4 Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions

FCT 5 Open Woodland of *Corymbia damperi* and *Corymbia zygophylla* over sparse Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula, Triodia microstachya* or *Triodia pungens* on orange to red pindan soils on lower to upperslope positions

FCT 6 Dense Low Heath of *Acacia tumida* var. *kulparn* over mixed shrubs including *Cassytha filiformis*, *Mukia maderaspatana* and *Pterocaulon sphacelatum* over Open Hummock Grassland of *Triodia pungens* and *Triodia schinzii* on red to brown pindan soils on rocky headlands

FCT 6d Disturbed areas of FCT 6

Other

BA Bare Areas

D Disturbed Areas

Quadrat
Detailed Recording Site

Conservation Significant Species

Kex:	*Keraudrenia exastia*	DRF (2008 locations from WEC)
Gby:	*Goodenia byrnesii*	P1
Par:	*Phyllanthus aridus*	P3
Tac:	*Triodia acutispicula*	P3
Scl:	*Scleria* sp.	Undescribed taxa

Limit of Broome Port Authority Survey Area

Keraudrenia exastia (DRF) Population Boundaries (provided by DEC)

DEC TEC 67: Monsoon Vine Thickets

DEC TEC 44: Roebuck Bay Mudflats

RARE AND PRIORITY SPECIES

Priority	DEC	Herb.	TEC	WEC
Rare	●	■	★	▲
1	●	■		▲
2	●	■		▲
3	●	■		▲
4	●	■		▲

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Scale 1:10,000
MGA94 (Zone 51)

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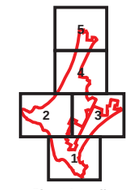

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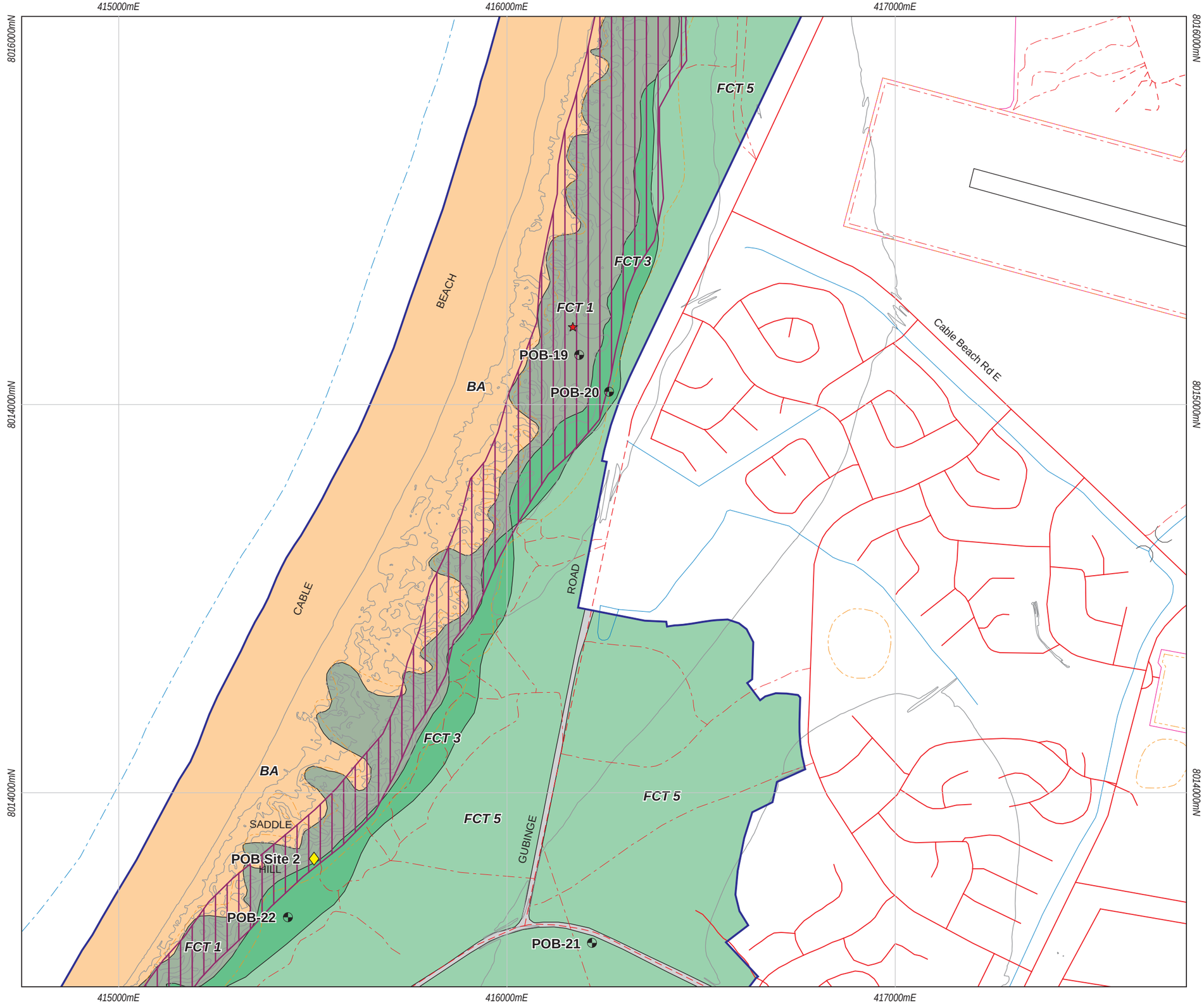
FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES AUGUST 2007

Sheet 3 of 5

woodmanenvironmentalconsulting
PO Box 50, Applecross W.A. 6953, A.C.N.088 055 903
Tel: (08) 9315 4688 ~ Fax: (08) 9315 4699

Author: C. Godden	WEC Ref: POB07-21-02	Scale: 1: 10,000
Drawn: CAD Resources ~ www.cadresources.com.au Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202		Figure: **3c**
CAD Ref: g1524_v03.dgn	Date: May 2008	Rev: **B** **A3**



LEGEND

FCT 1 Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes

FCT 2 Open Woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and Poaceae sp. 2 on orange sand on secondary dunes

FCT 3 Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia petiolaris* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlanii* and *Abrus precatorius* subsp. *precatorius* on pale orange to brown sand on lowerslopes behind dunes, and secondary dunes

FCT 3d Disturbed areas of FCT 3

FCT4 Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions

FCT 5 Open Woodland of *Corymbia damperi* and *Corymbia zygophylla* over sparse Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula, Triodia microstachya* or *Triodia pungens* on orange to red pindan soils on lower to upperslope positions

FCT 6 Dense Low Heath of *Acacia tumida* var. *kulparn* over mixed shrubs including *Cassytha filiformis*, *Mukia maderaspatana* and *Pterocaulon sphacelatum* over Open Hummock Grassland of *Triodia pungens* and *Triodia schinzii* on red to brown pindan soils on rocky headlands

FCT 6d Disturbed areas of FCT 6

Other

BA Bare Areas

D Disturbed Areas

Quadrat
Detailed Recording Site

Conservation Significant Species

Kex:	*Keraudrenia exastia*	DRF (2008 locations from WEC)
Gby:	*Goodenia byrnesii*	P1
Par:	*Phyllanthus aridus*	P3
Tac:	*Triodia acutispicula*	P3
Scl:	*Scleria* sp.	Undescribed taxa

Limit of Broome Port Authority Survey Area

Keraudrenia exastia (DRF) Population Boundaries (provided by DEC)

DEC TEC 67: Monsoon Vine Thickets

DEC TEC 44: Roebuck Bay Mudflats

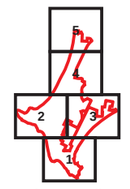
RARE AND PRIORITY SPECIES

Priority	DEC	Herb.	TEC	WEC
Rare	●	■	★	▲
1	●	■		▲
2	●	■		▲
3	●	■		▲
4	●	■		▲

0 100 200m

Scale 1:10,000
MGA94 (Zone 51)

N



Sheet Locality

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FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES AUGUST 2007

Sheet 4 of 5

woodmanenvironmentalconsulting
PO Box 50, Applecross W.A. 6953, A.C.N.088 055 903
Tel: (08) 9315 4688 ~ Fax: (08) 9315 4699

Author: C. Godden	WEC Ref: POB07-21-02	Scale: 1: 10,000
Drawn: CAD Resources ~ www.cadresources.com.au Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202		Figure: **3d**
CAD Ref: g1524_v04.dgn	Date: May 2008 | Rev: **B** | **A3**	

415000mE
416000mE
417000mE
8018000mN
8017000mN
8016000mN

Cable Beach Resort
Ocean Drive
Cable Beach Road West
FCT 5
FCT 1
BA
POB-28
POB-29
D

LEGEND

FCT 1 Shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghamii* subsp. *cunninghamii* with occasional *Bauhinia cunninghamii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredunes and on leeward side of foredunes

FCT 2 Open Woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and Poaceae sp. 2 on orange sand on secondary dunes

FCT 3 Open Woodland of mixed species including *Bauhinia cunninghamii* and *Terminalia petiolaris* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlanii* and *Abrus precatorius* subsp. *precatorius* on pale orange to brown sand on lowerslopes behind dunes, and secondary dunes

FCT 3d Disturbed areas of FCT 3

FCT4 Open Woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcata* over Shrubland dominated by *Acacia colei* var. *colei* and other species such as *Ehretia saligna* var. *saligna* and *Waltheria indica* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions

FCT 5 Open Woodland of *Corymbia damperi* and *Corymbia zygophylla* over sparse Shrubland of *Acacia colei* var. *colei* and *Acacia eriopoda* over grassland dominated by *Triodia acutispicula, Triodia microstachya* or *Triodia pungens* on orange to red pindan soils on lower to upperslope positions

FCT 6 Dense Low Heath of *Acacia tumida* var. *kulparn* over mixed shrubs including *Cassytha filiformis*, *Mukia maderaspatana* and *Pterocaulon sphacelatum* over Open Hummock Grassland of *Triodia pungens* and *Triodia schinzii* on red to brown pindan soils on rocky headlands

FCT 6d Disturbed areas of FCT 6

Other

BA Bare Areas

D Disturbed Areas

Quadrat
Detailed Recording Site

Conservation Significant Species

Kex:	*Keraudrenia exastia*	DRF (2008 locations from WEC)
Gby:	*Goodenia byrnesii*	P1
Par:	*Phyllanthus aridus*	P3
Tac:	*Triodia acutispicula*	P3
Scl:	*Scleria* sp.	Undescribed taxa

Limit of Broome Port Authority Survey Area

Keraudrenia exastia (DRF) Population Boundaries (provided by DEC)

DEC TEC 67: Monsoon Vine Thickets

DEC TEC 44: Roebuck Bay Mudflats

RARE AND PRIORITY SPECIES

Priority	DEC	Herb.	TEC	WEC
Rare	●	■	★	▲
1	●	■		▲
2	●	■		▲
3	●	■		▲
4	●	■		▲

0 100 200m

Scale 1:10,000
MGA94 (Zone 51)

N

Sheet Locality

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FLORISTIC COMMUNITY TYPES & LOCATIONS OF SIGNIFICANT FLORA SPECIES AUGUST 2007

Sheet 5 of 5

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Appendix A: Definitions, Categories and Criteria for Threatened and Priority Ecological Communities (Department of Environment and Conservation 2007)

2: Definitions and Criteria for Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable Ecological Communities

Presumed Totally Destroyed (PD)

An ecological community which has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or**

B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more of** the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long term future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

3: Definitions and Criteria for Priority Ecological Communities

Priority One: Poorly-Known ecological communities

Ecological communities with apparently few, small occurrences, all or mostly not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases), and for which current threats exist. Communities may be included if they are comparitively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-Known ecological communities

Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State Forest, unallocated Crown Land, water reserves, etc.) and not under immediate threat of destruction or degradation. Communities may be included if they are comparitively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes.

Priority Three: Poorly-Known ecological communities

(i.) Communities that are known from several to many occurences, a significant number of area of which are not under threat of habitat destruction or degradation or:

(ii.) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under immediate threat, or,

(iii.) communities made up of large, and/or widespread occcurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparitively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Poorly-Known ecological communities

Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(a) Rare. Ecological communities known from a few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close for qualifying for Vulnerable.
(c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation-Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessastion of which would result in the community becoming threatened within five years.

Appendix B: Description of Conservation Codes (Department of Environment and Conservation 2008b)

R: Declared Rare Flora – Extant Taxa

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

X: Declared Rare Flor a – Presumed Extinct Taxa

Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.

1: Priority One – Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

2: Priority Two – Poorly Known Taxa

Taxa which are known from one or a few (generally <5) pouplations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

3: Priority Three – Poorly Known Taxa

Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

4: Priority Four – Rare Taxa

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Appendix C: GPS Locations of All Quadrats and Sites Established in August 2007, Port of Broome

Note: All datum presented in GDA94

Quadrat	Zone	Easting	Northing	Corner Permanently Pegged	Floristic Community Type
POB-01	51	416043	8009033	South-east	1
POB-02	51	416149	8008941	South-east	3
POB-03	51	415633	8009865	South-west	4
POB-04	51	415545	8010447	South-west	4
POB-05	51	415235	8010584	North-west	4
POB-06	51	414933	8010477	North-west	4
POB-07	51	414765	8010332	North-west	1
POB-08	51	415597	8009483	Northern; plot extends at 135^{o} and 225^{o} from peg	1
POB-09	51	415102	8009870	North-west	4
POB-10	51	416205	8010684	North-west	2
POB-11	51	413159	8012332	North-west	4
POB-12	51	414351	8012024	North-west	5
POB-13	51	414386	8012216	South-west	5
POB-14	51	415562	8011634	South-east	5
POB-15	51	414798	8011239	South-west	4
POB-16	51	415484	8012871	North-west	5
POB-17	51	416052	8012902	South-east	5
POB-18	51	414639	8012954	North-east	1
POB-19	51	416186	8015128	North-east	1
POB-20	51	416263	8015033	North-west	3
POB-21	51	416219	8013613	North-west	5
POB-22	51	415436	8013679	North-east	3
POB-23	51	416789	8013052	South-east	5
POB-24	51	416384	8012466	South-east	5
POB-25	51	416312	8011616	South-west	5
POB-26	51	418036	8012697	South-east	5
POB-27	51	415363	8010152	South-west	4
POB-28	51	416715	8016558	North-west	5
POB-29	51	416424	8016318	South-east	1
POB-30	51	414696	8012718	South-east	5
POB-31	51	414022	8011686	-	6
Site-01	51	413682	8011845	-	
Site-02	51	415503	8013830	-	
Site-03	51	417970	8012283	-	

Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Poaceae	*Aristida holathera* var. ?*holathera*	
	Aristida holathera var. *latifolia*	
	**Cenchrus ciliaris*	
	**Chloris barbata*	
	Chrysopogon fallax	
	Cymbopogon procerus	
	Eragrostis eriopoda	
	Eragrostis sp.	
	Eriachne melicacea	
	Eriachne obtusa	
	Eriachne semiciliata	
	Panicum ?*decompositum*	
	Panicum effusum	
	Panicum laevinode	
	Poaceae sp. 1	
	Poaceae sp. 2	
	Setaria dielsii	
	**Setaria verticillata*	
	Sorghum stipoideum	
	Spinifex longifolius	
	Sporobolus australasicus	
	Triodia acutispicula	P3
	Triodia microstachya	
	Triodia pungens	
	Triodia schinzii	
Cyperaceae	*Bulbostylis barbata*	
	Cyperus conicus	
	Fimbristylis ammobia	
	Fimbristylis sp.	
	Scleria sp.	
Commelinaceae	*Murdannia graminea*	
Anthericaceae	*Corynotheca micrantha* var. *gracilis*	
Moraceae	*Ficus aculeata* var. *indecora*	

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Family	Species	Cons. Code
Proteaceae	*Grevillea pyramidalis*	
	Grevillea refracta subsp. *refracta*	
	Hakea arborescens	
	Hakea macrocarpa	
	Persoonia falcata	
Santalaceae	*Exocarpos latifolius*	
	Santalum lanceolatum	
Loranthaceae	*Amyema benthamii*	
	Lysiana spathulata subsp. *spathulata*	
Chenopodiaceae	*Salsola tragus* subsp. g*randiflora*	
Amaranthaceae	*Achyranthes aspera*	
	**Aerva javanica*	
	Amaranthus mitchellii	
	Ptilotus lanatus var. *lanatus*	
	Ptilotus polystachyus var. *arthrotrichus*	
Nyctaginaceae	*Boerhavia gardneri*	
Gyrostemonaceae	*Gyrostemon tepperi*	
Aizoaceae	*Trianthema pilosa*	
Portulacaceae	*Calandrinia strophiolata*	
Caryophyllaceae	*Polycarpaea corymbosa*	
	Polycarpaea longiflora	
Menispermaceae	*Tinospora smilacina*	
Lauraceae	*Cassytha capillaris*	
	Cassytha filiformis	
Hernandiaceae	*Gyrocarpus americanus* subsp. *pachyphyllus*	
Capparaceae	*Capparis lasiantha*	

Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Byblidaceae	*Byblis rorida*	
Mimosaceae	*Acacia adoxa* var. *subglabra*	
	Acacia ampliceps	
	Acacia bivenosa	
	Acacia colei var. *colei*	
	Acacia eriopoda	
	Acacia monticola	
	Acacia ?*monticola* x *tumida*	
	Acacia tumida var. *kulparn*	
	Acacia tumida var. *tumida*	
Caesalpiniaceae	*Bauhinia cunninghamii*	
	Caesalpinia major	
	Erythrophleum chlorostachys	
	Senna costata	
	Senna notabilis	
	Senna oligoclada	
Papilionaceae	*Abrus precatorius* subsp. *precatorius*	
	Cajanus marmoratus	
	Canavalia rosea	
	**Clitoria ternatea*	
	Crotalaria brevis	
	Crotalaria cunninghamii subsp. *cunninghamii*	
	Crotalaria medicaginea var. *neglecta*	
	Crotalaria ramosissima	
	Cullen martinii	
	Indigofera linifolia	
	**Macroptilium atropurpureum*	
	Rhynchosia minima	
	Tephrosia leptoclada	
	Tephrosia remotiflora	
	Tephrosia rosea var. *rosea*	
	Zornia prostrata var. *prostrata*	
Zygophyllaceae	*Tribulopis angustifolia*	
Meliaceae	*Melia azedarach*	

Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Polygalaceae	*Polygala tepperi*	
Euphorbiaceae	*Euphorbia alsiniflora*	
	Euphorbia coghlanii	
	Flueggea virosa subsp. *melanthesoides*	
	**Jatropha gossypifolia*	
	Mallotus nesophilus	
	Phyllanthus aridus	P3
	Phyllanthus exilis	
	Phyllanthus maderaspatensis	
	?*Phyllanthus* sp.	
Stackhousiaceae	*Stackhousia intermedia*	
Sapindaceae	*Distichostemon hispidulus* var. *aridus*	
Rhamnaceae	*Ventilago viminalis*	
	**Ziziphus mauritiana*	
Tiliaceae	*Corchorus sidoides* subsp. *vermicularis*	
	Grewia breviflora	
	Grewia retusifolia	
Malvaceae	*Abutilon indicum* var. *australiense*	
	Abutilon otocarpum	
	Gossypium australe	
	Hibiscus leptocladus	
	Sida ?*arenicola*	
	**Sida cordifolia*	
	Sida rohlenae subsp. *occidentalis*	
	Sida sp. B Kimberley Flora (A.A. Mitchell 2745)	
Sterculiaceae	*Brachychiton diversifolius* subsp. *diversifolius*	
	Keraudrenia exastia	R
	Keraudrenia ?*nephrosperma*	
	Melhania oblongifolia	
	Waltheria indica	
Violaceae	*Hybanthus aurantiacus*	

Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Passifloraceae	**Passiflora foetida* var. *hispida*	
Combretaceae	*Terminalia ferdinandiana*	
	Terminalia ferdinandiana x petiolaris	
	?*Terminalia latipes*	
	Terminalia petiolaris	
Myrtaceae	*Corymbia dampieri*	
	Corymbia flavescens	
	Corymbia grandifolia subsp. *longa*	
	Corymbia paractia	
	Corymbia polycarpa	
	Corymbia zygophylla	
	Eucalyptus tectifica	
Sapotaceae	*Sersalisia sericea*	
Oleaceae	*Jasminum didymum* subsp. *lineare*	
Apocynaceae	*Carissa lanceolata*	
Asclepiadaceae	*Marsdenia viridiflora* subsp. *tropica*	
	Marsdenia geminata	
	Tylophora cinerascens	
Convolvulaceae	*Bonamia linearis*	
	Ipomoea pes-caprae subsp. *brasiliensis*	
	Jacquemontia paniculata	
	**Merremia dissecta*	
	Polymeria ambigua	
Boraginaceae	*Ehretia saligna* var. *saligna*	
	Heliotropium foliatum	
	Heliotropium leptaleum	
	Trichodesma zeylanicum var. *zeylanicum*	
Lamiaceae	*Clerodendrum tomentosum* var. ?*mollissima*	
	**Hyptis suaveolens*	
	Premna acuminata	

Appendix D: Vascular Plant Taxa Recorded within the Port of Broome Survey Area, August 2007

Family	Species	Cons. Code
Solanaceae	*Solanum cunninghamii*	
Scrophulariaceae	*Striga curviflora*	
Bignoniaceae	*Dolichandrone heterophylla*	
Acanthaceae	*Hypoestes floribunda* var. *varia*	
Myoporaceae	*Myoporum montanum*	
Rubiaceae	*Gardenia pyriformis* subsp. *keartlandii*	
	Psydrax attenuata var. *tenella*	
	Spermacoce aff. *brachystema*	
	Spermacoce laevigata	
Cucurbitaceae	*Mukia maderaspatana*	
Goodeniaceae	*Goodenia armitiana*	
	Goodenia byrnesii	P1
	Goodenia sepalosa var. *sepalosa*	
	Scaevola parvifolia subsp. *parvifolia*	
	Velleia panduriformis	
Asteraceae	**Emilia sonchifolia*	
	Pterocaulon sphacelatum	
	**Tridax procumbens*	

Note: * denotes introduced taxa

Appendix E: Standard Control Codes for Declared Plants (Department of Agriculture and Food 2008)

Standard Control Code	Aim	Required Control
P1	Prohibits Movement	Movement of plants or their seed is prohibited within the state
		Prohibits the movement of contaminated machinery and produce including livestock and fodder
P2	Aim is to Eradicate Infestation	Treat all plants to destroy and prevent propagation each year until no plants remain. The infestated area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery
P3	Aims to control infestation by reducing area and/or density of infestation	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the prpoerty on or in livestock, fodder, grain, vehicles and/or machinery.
		Treat to destroy and prevent seed set all plants: - within 100 metres inside of the boundaries of the infestated property within 50 metres of roads and highwater mark on waterways within 50 metres of sheds, stock yards and houses
		Of the remaining infested area: where plant density is 1 - 10 per hectare treat 100% of infestation where plant density is 11 - 100 per hectare treat 50% of infestation where plant density is 101 - 1000 per hectare treat 10% of infestation
		Properties with less than 2 hectares of infestation must treat the entire infestation
		Additional areas may be ordered to be treated
P4	Aims to prevent infestation spreading beyond existing boundaries of infestation	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the prpoerty on or in livestock, fodder, grain, vehicles and/or machinery
		Treat to destroy and prevent seed set all plants: - within 100 metres inside of the boundaries of the infestated property within 50 metres of roads and highwater mark on waterways within 50 metres of sheds, stock yards and houses
		Treatment must be done prior to seed set each year. Properties with less than 2 hectares of infestation must treat the entire infestation.
		Additional areas may be ordered to be treated.
		In the case of P4 infestations where they continue across property boundaries there is no requirement to treat the relevant part of the property boundaries as long as the boundaries of the infestation as a whole are treated. There must be agreement between neighbours in relation to the treatment of these areas.

Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007

Species Name	FCT 1	2	3	4	5	6
Abrus precatorius subsp. *precatorius*	X		X		X	
Abutilon indicum var. *australiense*	X					
Abutilon otocarpum		X			X	
Acacia adoxa var. *subglabra*				X	X	
Acacia ampliceps			X			
Acacia bivenosa	X		X			
Acacia colei var. *colei*	X	X	X	X	X	
Acacia eriopoda				X	X	
Acacia monticola	X				X	
Acacia ?*monticola* x *tumida*					X	
Acacia tumida var. *kulparn*						X
Acacia tumida var. *tumida*	X			X		
Achyranthes aspera	X					
**Aerva javanica*	X		X			
Amaranthus mitchellii	X	X				
Amyema benthamii	X		X			
Aristida holathera var. ?*holathera*	X		X	X	X	
Aristida holathera var. *latifolia*						X
Bauhinia cunninghamii	X		X	X	X	
Boerhavia gardneri	X	X				
Bonamia linearis					X	
Brachychiton diversifolius subsp. *diversifolius*					X	
Bulbostylis barbata	X			X	X	
Byblis rorida					X	
Caesalpinia major	X					
Cajanus marmoratus			X		X	X
Calandrinia strophiolata	X			X	X	
Canavalia rosea	X					
Capparis lasiantha		X	X			
Carissa lanceolata			X	X	X	X
Cassytha capillaris			X	X	X	
Cassytha filiformis	X			X	X	X
**Cenchrus ciliaris*			X			

Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007

	FCT					
Species Name	**1**	**2**	**3**	**4**	**5**	**6**
**Chloris barbata*			X			
Chrysopogon fallax			X	X	X	
Clerodendrum tomentosum var. ?*mollissima*	X			X		
**Clitoria ternatea*	X		X			
Corchorus sidoides subsp. *vermicularis*	X		X	X	X	
Corymbia dampieri			X	X	X	
Corymbia flavescens	X		X	X		
Corymbia grandifolia subsp. *longa*			X			
Corymbia paractia				X		
Corymbia polycarpa		X			X	
Corymbia zygophylla				X	X	
Corynotheca micrantha var. *gracilis*				X		
Crotalaria brevis		X			X	
Crotalaria cunninghamii subsp. *cunninghamii*	X	X			X	
Crotalaria medicaginea var. *neglecta*	X		X	X	X	
Crotalaria ramosissima					X	
Cullen martinii			X			
Cymbopogon procerus				X	X	
Cyperus conicus		X				
Distichostemon hispidulus var. *aridus*					X	
Dolichandrone heterophylla				X	X	
Ehretia saligna var. *saligna*			X	X	X	
**Emilia sonchifolia*			X			
Eragrostis eriopoda	X	X		X	X	
Eragrostis sp.					X	
Eriachne melicacea				X		
Eriachne obtusa				X	X	X
Eriachne semiciliata				X		
Erythrophleum chlorostachys				X		X
Eucalyptus tectifica			X		X	
Euphorbia alsiniflora				X	X	X
Euphorbia coghlanii	X	X	X	X		
Exocarpos latifolius			X			

Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007

Species Name	FCT 1	2	3	4	5	6
Ficus aculeata var. *indecora*	X	X	X	X	X	
Fimbristylis ammobia					X	
Fimbristylis sp.					X	
Flueggea virosa subsp. *melanthesoides*		X			X	
Gardenia pyriformis subsp. *keartlandii*			X	X	X	X
Goodenia armitiana				X		
Goodenia byrnesii				X	X	
Goodenia sepalosa var. *sepalosa*				X		
Gossypium australe					X	
Grevillea pyramidalis				X	X	X
Grevillea refracta subsp. *refracta*					X	
Grewia breviflora	X		X			
Grewia retusifolia					X	
Gyrocarpus americanus subsp. *pachyphyllus*	X		X	X	X	
Gyrostemon tepperi	X	X		X	X	
Hakea arborescens			X		X	
Hakea macrocarpa	X			X	X	
Heliotropium foliatum					X	
Heliotropium leptaleum	X			X	X	
Hibiscus leptocladus				X	X	X
Hybanthus aurantiacus				X	X	X
Hypoestes floribunda var. *varia*	X					
**Hyptis suaveolens*			X			
Indigofera linifolia				X	X	
Ipomoea pes-caprae subsp. *brasiliensis*	X					
Jacquemontia paniculata			X		X	
Jasminum didymum subsp. *lineare*		X	X	X	X	
**Jatropha gossypifolia*			X		X	
Keraudrenia exastia				X		
Keraudrenia ?*nephrosperma*					X	
Lysiana spathulata subsp. *spathulata*	X			X	X	
**Macroptilium atropurpureum*			X			
Mallotus nesophilus	X					

Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007

	FCT					
Species Name	**1**	**2**	**3**	**4**	**5**	**6**
Marsdenia geminata		X				
Marsdenia viridiflora subsp. *tropica*					X	
Melhania oblongifolia	X			X	X	
Melia azedarach			X			
**Merremia dissecta*			X	X		
Mukia maderaspatana	X			X	X	X
Murdannia graminea				X	X	X
Myoporum montanum	X					
Panicum ?decompositum			X			
Panicum effusum				X	X	
Panicum laevinode	X	X	X			
**Passiflora foetida* var. *hispida*	X	X	X	X	X	X
Persoonia falcata				X	X	
Phyllanthus aridus				X		
Phyllanthus exilis				X	X	
Phyllanthus maderaspatensis				X	X	
?*Phyllanthus* sp.				X		
Poaceae sp. 1	X					
Poaceae sp. 2	X					
Polycarpaea corymbosa					X	
Polycarpaea longiflora				X	X	
Polygala tepperi				X	X	
Polymeria ambigua			X	X	X	
Premna acuminata	X			X		
Psydrax attenuata var. *tenella*				X	X	
Pterocaulon sphacelatum				X	X	X
Ptilotus lanatus var. *lanatus*				X	X	
Ptilotus polystachyus var. *arthrotrichus*					X	
Rhynchosia minima					X	
Salsola tragus subsp. *grandiflora*				X		
Santalum lanceolatum	X		X	X	X	
Scaevola parvifolia subsp. *parvifolia*				X		
Scleria sp.				X	X	

Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007

	FCT					
Species Name	**1**	**2**	**3**	**4**	**5**	**6**
Senna costata				X	X	
Senna notabilis					X	
Senna oligoclada					X	
Sersalisia sericea			X	X	X	
Setaria dielsii						X
**Setaria verticillata*				X		
Sida ?*arenicola*					X	
**Sida cordifolia*		X				
Sida rohlenae subsp. *occidentalis*				X	X	
Sida sp. B Kimberley Flora (A.A. Mitchell 2745)				X	X	
Solanum cunninghamii				X	X	
Sorghum stipoideum			X			
Spermacoce aff. *brachystema*	X			X	X	
Spermacoce laevigata	X			X	X	
Spinifex longifolius	X	X				
Sporobolus australasicus			X			
Stackhousia intermedia					X	
Striga curviflora					X	
Tephrosia leptoclada			X	X	X	
Tephrosia remotiflora			X		X	
Tephrosia rosea var. *rosea*	X	X	X	X		
Terminalia ferdinandiana			X	X	X	
Terminalia ferdinandiana x petiolaris						X
?*Terminalia latipes*		X			X	
Terminalia petiolaris	X		X	X	X	
Tinospora smilacina	X		X	X		
Trianthema pilosa	X	X		X	X	
Tribulopis angustifolia					X	
Trichodesma zeylanicum var. *zeylanicum*		X	X	X	X	
**Tridax procumbens*				X		
Triodia acutispicula	X	X		X	X	
Triodia microstachya					X	
Triodia pungens	X		X	X	X	X

Appendix F: Vascular Plant Taxa Recorded Within Quadrats, Within Each Floristic Community Type, August 2007

	FCT					
Species Name	**1**	**2**	**3**	**4**	**5**	**6**
Triodia schinzii					X	X
Tylophora cinerascens	X	X			X	
Velleia panduriformis				X		
Ventilago viminalis				X	X	X
Waltheria indica		X	X	X	X	
**Ziziphus mauritiana*	X					
Zornia prostrata var. *prostrata*			X	X	X	X

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 1: *Keraudrenia exastia* (Declared Rare Flora) (Section 4.1.1)

Plate 2: *Abrus precatorius* subsp. *precatorius* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 3: *Ficus aculeata* var. *orbicularis* ms (Table 10)

Plate 4: *Persoonia falcata* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 5: *Tephrosia rosea* var. *rosea* (Table 10)

Plate 6: *Tephrosia rosea* var. *rosea* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 7: *Grevillea pyramidalis* subsp. *pyramidalis* (Table 10)

Plate 8: *Mallotus nesophilus* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 9: *Ventilago viminalis* (Table 10)

Plate 10: *Ventilago viminalis* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 11: *Bauhinia cunninghamii* (Table 10)

Plate 12: *Bauhinia cunninghamii* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 13: *Carissa lanceolata* (Table 10)

Plate 14: *Crotalaria cunninghamii subsp. cunninghamii* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 15: *Tinospora smilacina* (Table 10)

Plate 16: *Hakea macrocarpa* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 17: *Santalum lanceolatum* (Table 10)

Plate 18: *Santalum lanceolatum* (Table 10)

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 19: Quadrat POB-01

Plate 20: Quadrat POB-02

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

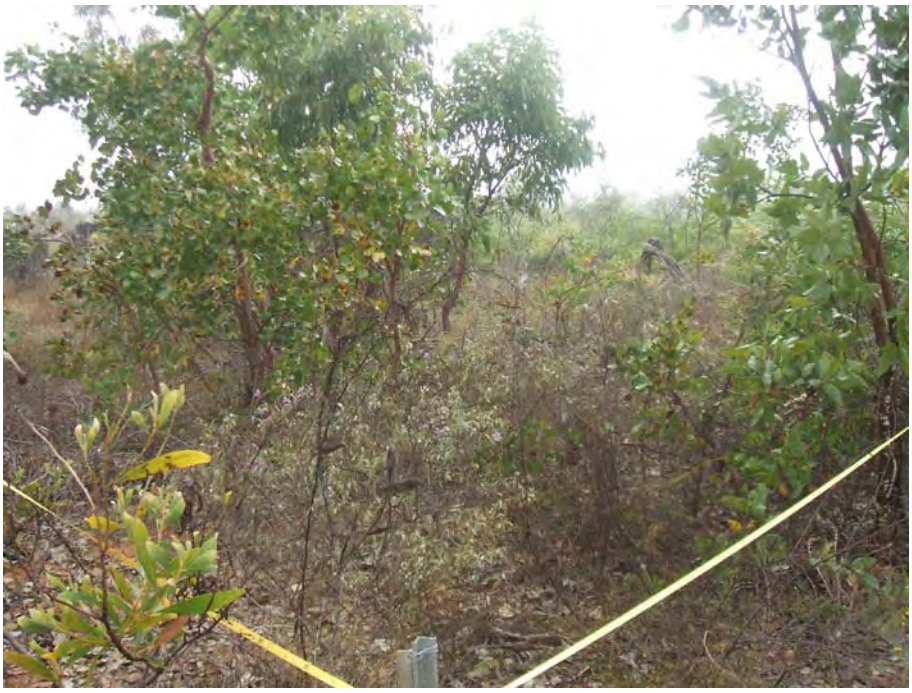


Plate 21: Quadrat POB-03

Plate 22: Quadrat POB-04

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 23: Quadrat POB-05

Plate 24: Quadrat POB-06

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 25: Quadrat POB-07

Plate 26: Quadrat POB-08

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 27: Quadrat POB-09

Plate 28: Quadrat POB-10

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 29: Quadrat POB-11

Plate 30: Quadrat POB-12

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 31: Quadrat POB-13

Plate 32: Quadrat POB-14

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 33: Quadrat POB-15

Plate 34: Quadrat POB-16

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 35: Quadrat POB-17

Plate 36: Quadrat POB-18

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 37: Quadrat POB-19

Plate 38: Quadrat POB-20

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 39: Quadrat POB-21

Plate 40: Quadrat POB-22

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 41: Quadrat POB-23

Plate 42: Quadrat POB-24

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 43: Quadrat POB-25

Plate 44: Quadrat POB-26

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 45: Quadrat POB-27

Plate 46: Quadrat POB-28

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 47: Quadrat POB-29

Plate 48: Quadrat POB-30

Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

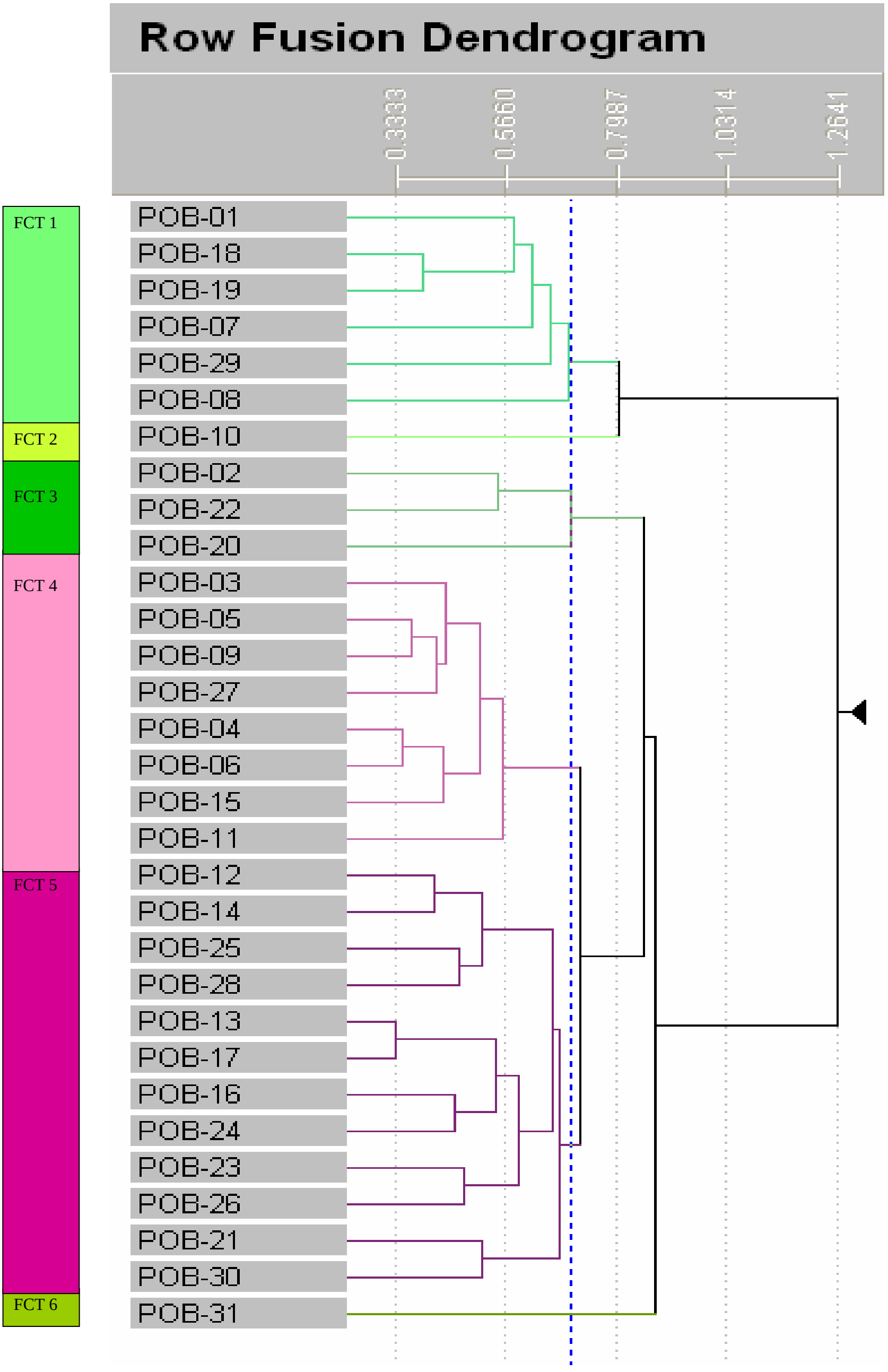
Plate 49: Quadrat POB-31

Plate 50: Site POB-02

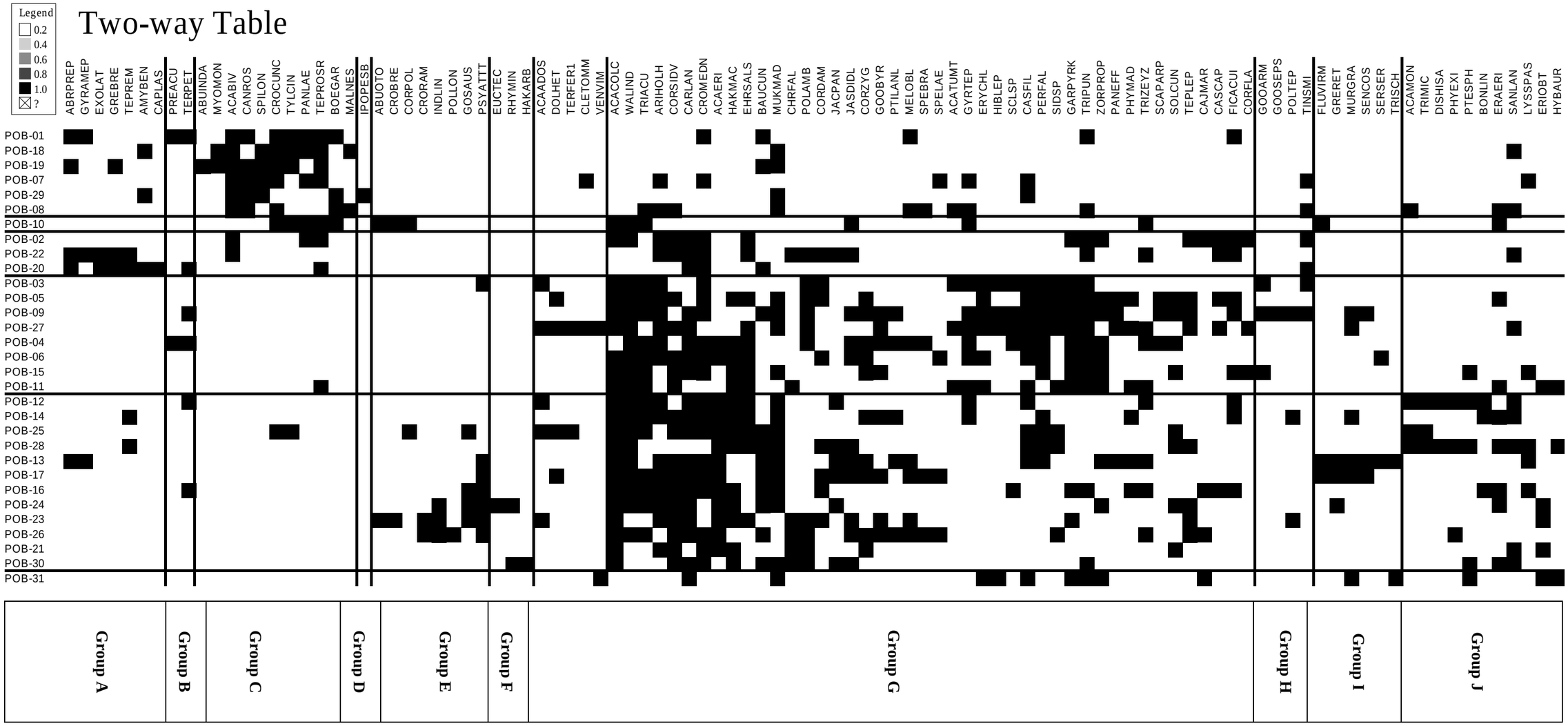
Appendix G: Photographs of Plant Taxa and Quadrats, August 2007 and April 2008

Plate 51: Site POB-03

Appendix H: Summary Dendrogram of Relationships between Floristic Community Types, Broome Port Authority Quadrat Data



Appendix I: Two-way Table, Ordination of Port of Broome Quadrat Data (PATN: Belbin 1989)



Group A	Group B	Group C	Group D	Group E	Group F	Group G	Group H	Group I	Group J

Appendix J: Indicator Species Values (Monte Carlo Test), Broome Port Authority Quadrat Data

Note: Shading denotes highest indicator values per taxon. Indicator values (%) are shown only for taxa which were significant at $p < 0.05$ (Monte Carlo permutation tests: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$)

Species	**1**	**3**	**4**	**5**
Acacia bivenosa *	60	27		
Acacia colei var. *colei* ***		5	35	45
Acacia eriopoda ***			5	72
Boerhavia gardneri *	50	0	0	0
Canavalia rosea ***	83	0	0	0
Carissa lanceolata *	0	41	16	28
Cassytha capillaris *	0	44	6	1
Cassytha filiformis **	7	0	50	7
Crotalaria cunninghamii subsp. *cunninghamii* **	76	0	0	1
Erythrophleum chlorostachys **	0	0	75	0
Exocarpos latifolius **	0	67	0	0
Gardenia pyriformis subsp. *keartlandii* ***	0	7	67	2
Goodenia armitiana *	0	0	38	0
Grewia breviflora *	3	53	0	0
Gyrostemon tepperi *	9	0	45	2
Hibiscus leptocladus *	0	0	38	0
Mallotus nesophilus *	33	0	0	0
Myoporum monatum *	33	0	0	0
Persoonia falcata ***	0	0	63	9
Psydrax attenuata var. *tenella* *	0	0	3	40
Scaevola parvifolia subsp. *parvifolia* *	0	0	38	0
Scleria sp. *	0	0	43	1
Sida sp. B Kimberley Flora (A.A. Mitchell 2745) *	0	0	45	7
Spinifex longifolius **	67	0	0	0
Tephrosia remotiflora **	0	53	0	3
Triodia acutispicula **	2	0	47	21
Triodia pungens *	5	21	46	1
Waltheria indica **	0	5	48	27
Zornia prostrata var. *prostrata* *	0	9	45	2

Appendix K: Locations and Plant Numbers of *Keraudrenia exastia* , Port of Broome

Location 1 (Population 'C')		
GPS Easting	**GPS Northing**	**Number of plants**
415567	8009749	4
415560	8009744	18
415548	8009749	6
415539	8009748	6
415531	8009749	4
415513	8009747	3
415508	8009750	14
415481	8009750	6
415451	8009744	3
415427	8009751	2
415512	8009824	4
415676	8009892	15
415565	8009888	2
415622	8009772	1
415601	8009775	2
415575	8009765	2
415570	8009765	2
415565	8009762	3
415554	8009761	3
415549	8009770	1
415545	8009773	2
415539	8009774	2
415532	8009773	2
415532	8009758	8
415533	8009763	5
415513	8009769	1
415512	8009762	5
415493	8009771	3
415481	8009770	4
415467	8009768	2
415463	8009773	10
415455	8009764	10
415452	8009764	10
415447	8009766	10
415445	8009761	6
415441	8009765	10
415437	8009764	10
415432	8009763	4
415373	8009773	50
415526	8009830	1

GPS Easting	GPS Northing	Number of plants
415529	8009830	1
415551	8009818	1
415669	8009903	5
415541	8009678	1
415515	8009688	20
415509	8009676	1
415508	8009684	10
415508	8009686	30
415505	8009690	25
415498	8009687	17
415498	8009690	12
415496	8009693	6
415498	8009695	7
415450	8009677	3
415482	8009684	1
415467	8009706	7
415561	8009847	4
415563	8009856	1
415688	8009852	15
415570	8009596	20
415602	8009654	30
415434	8009665	3
415628	8009712	8
415623	8009706	7
415563	8009710	12
415563	8009717	8
415557	8009731	30
415557	8009714	14
415553	8009704	17
415563	8009701	9
415570	8009695	9
415553	8009677	20
415547	8009672	7
415537	8009710	8
415527	8009695	38
415521	8009702	23
415515	8009708	17
415512	8009735	11
415500	8009736	3
415492	8009711	1
415480	8009707	18
415464	8009715	20
415434	8009732	14
415371	8009775	20

GPS Easting	GPS Northing	Number of plants
415395	8009780	5
415406	8009788	22
415425	8009795	2
415455	8009789	2
415467	8009794	7
415502	8009780	1
415515	8009788	5
415539	8009784	2
415548	8009798	20
415548	8009794	18
415548	8009780	20
415685	8009866	9
415628	8009874	8
Total		**911**

Note: The following locations provide the boundary of the second *Keraudrenia exastia* population (North-western most population). Approximately 20,000 individuals occur in this population.

Location 2	
GPS Easting	**GPS Northing**
415187	8009843
415208	8009835
415221	8009855
415228	8009847
415244	8009847
415257	8009858
415273	8009875
415267	8009885
415264	8009903
415267	8009910
415270	8009911
415183	8009854
415196	8009861
415166	8009877
415168	8009887
415176	8009896
415181	8009905
415190	8009912
415196	8009923
415210	8009925
415226	8009932
415241	8009937
415257	8009926
415261	8009918
415267	8009871
415247	8009867
415189	8009872
415167	8009879

Appendix L: Proposed Environmental Management Plan Outline – Native Vegetation, Port of Broome

Two objectives of the project were:

- Formulate outline of a management plan for the environmental corridor (including strategies to encourage endangered flora species within the corridor)
- Formulate outline of a weed management plan.

This appendix addresses these objectives by providing an outline of an Environmental Management Plan (EMP) for remnant native vegetation on Port of Broome managed lands and including brief descriptions of potential content of the various sections of the EMP.

EMP OUTLINE

SECTION	DESCRIPTION
Introduction	
Scope of the document	This EMP addresses the management of the remnant native vegetation of the Port of Broome managed lands with special emphasis placed on the environmental corridor.
Background	A description of the Port of Broome operations and the formation of the environment corridor.
Objectives	A list of key objectives of the EMP. This section should focus on the envisaged outcomes generated by the EMP such as; Improved stakeholder engagement regarding management of remnant vegetation on the Broome Peninsula.
Existing Environment	
Climate	A general description of the climate of the Broome Peninsula and how this may affect land management practices.
Soils	A general description of the soils of the Broome Peninsula and how this may affect land management practices.
Vegetation	A description of the vegetation and flora of the peninsula with emphasis on the Port of Broome managed lands. This section should be taken directly from this report.
Fauna	A description of the fauna of the peninsula with emphasis on the Port of Broome managed lands. This section should be taken directly from the Bamford report and relate to fauna

SECTION	DESCRIPTION
	habitats and their management.
Social	A description of the social environment of the Peninsula, both traditional and European.
Stakeholders	
Stakeholder groups	This section should identify the relevant stakeholder groups with an interest in the ongoing management of the remnant vegetation on the Port of Broome managed lands. It should include Government and Non-government groups and should describe the framework for stakeholder input to management.
Significant Environmental Factors and Risks	
Environmental values	This section should identify key environmental values of the area such as Declared Rare Flora, Environmental linkage, Fauna Habitat values, traditional use etc.
Risk Assessment	This section should identify threatening processes to the identified environmental values and rate them on a risk basis for management priority.
Management	
Management Objectives	This section should list specific objectives of managing the Port of Broome remnant native vegetation related to each identified threatening process. Each process should have a unique management plan developed to address its unique potential impacts. Some examples follow.
Rare Flora Management Plan	This plan should address protection of the existing populations through the identification of strategies and implementation of procedures. This plan does not address a threatening process as such, but due to the unique nature of Rare Flora and their governing legislation addresses the value itself. Features of this plan should include: • Protection from clearing or indirect impact; • Monitoring of population health; • Research to identify management practices that will ensure the sustainability of populations; and

SECTION	DESCRIPTION
	• Cooperative management of populations with stakeholder groups.
Weed Management Plan	This plan should address the following aspects: • Port of Broome road verge and cleared area weed spraying program; • Application of lease conditions to manage weeds on developed areas; • Machine and vehicle hygiene conditions for earthworks and transportation contractors; • Annual monitoring of weed populations to determine the efficacy of spraying programs.
Fire Management Plan	This plan should address the following aspects: • Responsibility for fire prevention and response on Port of Broome managed lands; • Mosaic burning of remnant native vegetation to address protection of infrastructure, traditional uses of the environmental corridor, management and regeneration of native vegetation and fauna habitat, management and regeneration of Rare Flora (research pending).
Drainage Management Plan	This plan should address management of run-off and discharged water from industrial sites to protect: • Groundwater quality; • Roebuck Bay Threatened Ecological Community; • Vegetation health; and • Rare Flora
Traditional Uses Management Plan	This plan should focus on consultation processes to identify the required traditional uses of the environmental corridor and flora of the Port of Broome managed lands in general. Management processes to address concerns or

SECTION	DESCRIPTION
	particular requirements can then be formulated and implemented during reviews of the document. Issues may include: • Retention or protection of particular sites or plants; • Inclusion of particular plants in landscaping projects; • Access to lands at particular times or for particular purposes.
Review and Reporting	
Review Period	A review period at which time the entire EMP should be reviewed should be identified to ensure that recent improvements or changes in management strategy or conditions are incorporated into the document. this will ensure that the document remains dynamic and relevant to Port of Broome operations and to the requirements of the stakeholder group. A review period of 3 years is recommended as an initial arbitrary period pending development and implementation of the EMP.
Reporting	This EMP is not currently proposed to be a legally binding document under any legislation, however it has direct relevance to both the stakeholder groups and the Broome Port Authority. Therefore the implementation and success of management activities should be discussed and reviewed annually in conjunction with a meeting of the stakeholder management group, with the outcomes to be reported to the Board of the Broome Port Authority for inclusion in annual reports.

Attachment G

Environmental Management Plan

ENVIRONMENTAL MANAGEMENT PLAN 2013

Broome Port Authority

Prepared by:

coffey

BROOME PORT
GEARED FOR GROWTH

BROOME PORT AUTHORITY
ENVIRONMENTAL MANAGEMENT PLAN

Current version number: 7.1 **File reference: ENV001/66052** **Maintained by: HSE Officer**

Original issue date: March 2004 **Last review date: September 2013** **Next review date: September 2014**

CONTENTS

FIGURES

TABLES

APPENDIX A: REGISTER OF LEGAL AND OTHER REQUIREMENTS

APPENDIX B: ENVIRONMENTAL MANAGEMENT GUIDANCE CARDS

VARIATION RECORD:

Version No.	Version Date:	Brief Description of Change:
	March 2004	Revision
	May 2008	Revision
	June 2009	Revision (supplementary EMP)
6.0	December 2010	Revision
7.0	September 2013	Revision incorporating new EMS and 2009 Supplementary EMP
7.1	December 2013	Risk assessment and legal and other requirements updated

Document originally prepared/revised by Coffey Environments Australia Pty Ltd. File ENAUPERT03627AC_1_EMP_v1. Library report reference EP2013/093.

1. INTRODUCTION

The Port of Broome is a busy deepwater port that has serviced the Kimberley region since 1889 and is located at the southern tip of Dampier Peninsula. The port supports Broome's pearling fleet as well as offshore oil and gas exploration supply vessels, oil tankers, livestock carriers, breakbulk or general cargo vessels, fishing vessels, charter boats, cruise liners, private vessels and Navy and Customs patrol vessels. The port is the main fuel and container hub port for the Kimberley region, and in recent years its principal exports have been livestock (typically some 30-40 shipments per year involving the loading of around 3,000 head per carrier) and offshore drilling rig equipment and materials. Broome Port Authority ("BrPA") has a strategically located land holding that is set aside for port related developments. Land is leased to tenants for a variety of purposes including an oil tank farm, aquaculture industries, training facilities, offshore supply bases, fishing club, hovercraft base and residential use.

Utilisation of the port is high based on comparisons with other small WA ports and for the last decade, Broome has experienced a high rate of growth in vessel visits (Egis 2002). The greatest areas of growth are in the offshore oil and gas industry, fuel shipments, the livestock trade and cruise shipping. The Kimberley region has substantial potential for economic growth in the resources, agricultural and tourism sectors and the Port is strategically situated to capitalise on this potential.

Under the *Port Authorities Act 1999* a port authority must annually prepare and submit to the responsible Minister a draft strategic development plan for the port authority and any subsidiary. Inter alia, the strategic development plan requires an Environmental Management Plan (EMP) for the port. An important function of the BrPA is to protect the environment of the port and to minimise the impact of port activities on the environment. The EMP is a "live" document that will address new activities that may arise at the port and incorporate any legislative changes or best practice conditions which may evolve from time to time.

1.1. EMP Scope and Objectives

With increasingly stringent environmental regulations and interest from local communities in protecting the natural and social environment, BrPA is faced with greater challenges to reduce real and perceived effects of its operations and those of its tenants. This EMP is a cost effective tool for addressing these environmental management challenges.

1.1.1.Scope

Under the *Port Authorities Act 1999*, an EMP submitted to the Minister by a Port Authority is to encompass all property within the Port Area (all Crown land in the port including the seabed and shores), all navigation aids in the port that belong to the State and all fixtures on land in the port that belong to the State. The property of a Port Authority also includes any improvements on vested land leased to another person that have been acquired on termination of the lease concerned and any real or personal property acquired by the Port Authority.

As such, the EMP is applicable to the following activities:

a) all activities conducted by BrPA;
b) activities undertaken by tenants within the Port Management Area (PMA); and

c) those operations conducted by contractors who operate within the PMA.

1.1.2. Objectives

The objectives of this EMP are:

a) to identify and consider the environmental issues likely to be encountered on the site;
b) to assess the risk of the environmental issues and prioritise them for action;
c) to formulate practical environmental management options and strategies to assist BrPA in meeting its environmental management obligations, taking into account existing procedures and mitigation measures; and
d) to describe specific procedures to be implemented by BrPA.

1.2. Outcomes

The desired outcomes of the EMP are:

a) a consistent approach to environmental management;
b) enhancement of BrPA staff and tenant awareness of their shared responsibility to protect the environment;
c) reduced operating costs by reducing the need for remedial actions;
d) enhanced public, customer and supplier perception of the Port through proactive protection of the natural and social environment; and
e) environmental management in accordance with legislative requirements.

1.3. EMP Structure

The EMP is an umbrella document that describes a framework for environmentally sustainable management of the Port. An activities-based approach has been adopted given that many activities onsite are conducted in discrete units and that several different tenants operate within the PMA.

This document comprises the following sections:

a) Section 2 provides a detailed description of daily port operations and tenant activities within the PMA;
b) Section 3 sets out the receiving environment by describing the regional setting and the physical, biological and socioeconomic features within the PMA;
c) Section 4 summarises BrPA's obligations with respect to the environment under various State and Commonwealth legislation;
d) Section 5 discusses controls currently in place to manage or mitigate adverse environmental impacts;
e) Section 6 summarises those port activities with potential to adversely impact the environment, describes the potential impacts and semi-quantitatively assesses the risk of these impacts taking into account existing environmental controls; and
f) Section 7 presents environmental controls and procedures that could be implemented to address identified environmental impacts. They are presented in a practical ‘guidance cards’ format and are applicable to BrPA daily operations. Environmental management of tenants is also discussed.

1.4. BrPA Environmental Management System

BrPA has implemented an Environmental Management System (EMS) in accordance with the requirements of ISO 14001:2004. The EMS incorporates policies, planning, procedures, practices, responsibilities, training, monitoring, review and audits that will together define a framework for managing the impact of BrPA's activities, products and services on the environment.

This EMP forms part of BrPA's EMS. It will be reviewed periodically and may be revised to incorporate changes in legislation, updated guidelines (e.g., as published by industry and government departments) or altered management practices. It may also be reviewed in response to an environmental incident or the identification of new or changed environmental risks.

Further details about the status of this version of the EMP and its integration into the EMS are discussed in section 7.4.

1.5. Site Description and Overview of Port Elements

The PMA is located at the southwest tip of the Dampier Peninsula, in the general area of Entrance Point, Broome, Western Australia. It presently comprises an extensive landholding of 200 ha described as Reserve 28650 and is zoned Port Zone under Broome Shire Town Planning Scheme No. 4. The waters in and around the port are part of Dampier Location 409 vested in BrPA by the Crown. Under the *Port Authorities Act 1999,* BrPA oversees all activities within its boundaries.

A steel pile jetty extends from the peninsula in an easterly direction, reaching the deeper waters of the Inner Anchorage within Roebuck Bay. This jetty is the main berthing facility for the region. A portion of land within the PMA is utilised for port related uses by the BrPA, a portion is leased to tenants, whilst the greater remainder is vacant. The various port land use elements are shown in Figure 1 and summarised in Table 1 below. Land use elements and associated activities are described in further detail in Section 2.

Table 1 Summary of Port Elements

Port Element	Owner / Leaseholder	BrPA Lease Reference No.
Jetty	BrPA	–
BrPA administration complex	BrPA, leased to Port City Investments who sub-let to Department of Fisheries, Customs, Wharf Restaurant and Department of Agriculture	LAN074
BrPA workshop, operations buildings and maintenance yard	BrPA	–
Logistics supply bases Lots 549, 537-550, 514	Leased to Toll Mermaid Logistics Broome Pty Ltd	LAN101, LAN095, LAN200
BP bulk fuel terminal	Leased to BP Australia Pty Ltd	LAN199
Shell bulk fuel terminal	Leased to Shell Company of Australia Limited	LAN104
Shell bitumen plant	Part of Shell bulk fuel terminal	LAN104
Aquaculture park and seawater pumping facilities	Leased to Department of Fisheries: sub-let to Kimberley College of TAFE, Paspaley Pearl Hatchery, Ocean and Earth Training	LAN076
Truck yards & cargo laydown/storage	Leased to Oilfield Transport Services Pty Ltd: part sub-let to Toll Mermaid Logistics Broome Pty Ltd	LAN012
Fishing Clubrooms	Leased to Broome Fishing Club	LAN078
Entrance point boat ramps	Managed by BrPA	–
Residential houses	Leased to Portbay Pty Ltd Leased to Marie Gamble Leased to William Robert Reed	LAN098 LAN102 LAN098
Hovercraft base	Leased to Holdage Pty Ltd	LAN088
Customs House	Leased to Port City Investments Pty Ltd	LAN014
Slipway	Managed by BrPA	–

Site and lot boundaries are approximate and are shown to illustrate indicative land use only.
Aerial imagery from Google Earth Pro (circa 2010)

coffey

Date: 06.09.2013
MXD: 3627_01_GIS003_v0_3
File Name: 3627AC_01_F001_GIS

Broome Port Authority

Environmental Management Plan

Port of Broome

Figure No: **1**

1.6. BrPA Environmental Policy

The Port recognises that the protection of the environment is a key business performance objective, and this is being reflected in the development of BrPA's EMS. BrPA's policy is to achieve "continual improvement, pollution prevention, and compliance with environmental legislation".

The key principles of the environmental policy are to:

a) conduct Port activities in a manner that minimises negative impacts on the environment through technological advancement, training and compliance with legislative requirements;
b) make appropriate use of raw materials, energy and water through better work practices and education of staff and relevant stakeholders;
c) take all reasonable measures to avoid pollution;
d) ensure environmental management is a core element of the Port's business plan and has the support of management staff and the board;
e) communicate openly with the community, government and industry on environmental issues, predicting and responding to concerns regarding environmental matters; and
f) conduct regular monitoring along with periodic external auditing to ensure the activities of the port are not impacting on the environment.

The procedures developed in this EMP are based upon and consistent with the key principles of BrPA's environmental policy.

2. DESCRIPTION OF OPERATIONS

2.1. Introduction

There are numerous activities undertaken within the PMA, both port and non-port related. In addition, there are a number of different parties involved such as BrPA, contractors, agents and tenants. For the purposes of this report, site activities have been categorised into three general areas:

a) activities and services that are managed by BrPA;

b) port related activities that are undertaken by other parties; and

c) activities undertaken by tenants or contractors.

2.2. Activities and Services Managed by BrPA

BrPA is charged with the role of overall management of the Port. This involves financial aspects, strategic planning, forecasting and development. In addition, Broome Port differs from many other Western Australian Ports in that the majority of day-to-day port activities (such as pilotage, stevedoring, navigation aid maintenance, anchorages, moorings, communications, channel maintenance, towage, cargo loading and discharge) are conducted in-house or otherwise arranged by BrPA. Activities that are undertaken by, or are the responsibility of, BrPA are discussed in greater detail below.

2.2.1. Strategic Planning and Coordination

BrPA is responsible for strategically planning and coordinating the optimum overall development of the Port. This function involves identifying suitable physical resources (e.g. land, deep water) available for future use and forecasting marine traffic, trade and future land use requirements. BrPA coordinates this information to develop strategic plans, as required under the *Port Authorities Act 1999*, that include adequate protection to the environment.

BrPA acts as a strategic Port Manager by taking an active role in seeking to maximise the reliability, efficiency and economy of services provided in the Port. This may involve implementing improved procedures, installing new equipment, adapting management and staffing strategies, better coordination of operators and contractors, and many other activities.

Following a review of regional ports in Western Australia in 2012, the Western Australian government is expected to amend the *Port Authorities Act 1999* in the latter half of 2013 to allow a port authority to have responsibility for more than one port. This amendment will enable the creation of regional port authorities, and BrPA will on 1 July 2014 become the Kimberley Ports Authority (KPA). KPA will have responsibility for the Ports of Broome, Derby, Wyndham, Cockatoo Island and Koolan Island. It is envisaged that KPA would also assume responsibility for any future port that may be developed at James Price Point in connection with offshore oil and gas field development in the Browse Basin.

2.2.2. Port Development

The current five year Strategic Development Plan (2010 – 2015) was prepared against an impending greater use of the Port by the offshore oil and gas industry. This will entail increased

requirements for berth space and services. To meet the increased requirements BrPA is considering the following strategic plans:

a) prepare a concept design for a second jetty that will provide greater shipping capability and flexibility;
b) develop general cargo (i.e. break bulk) shipping services to the region;
c) enhance the viability of traditional shipping services;
d) further develop the Port's support base role for the Browse Basin oil and gas province;
e) prepare for the support requirements of the nearby LNG Precinct; and
f) develop a bore water facility for the supply of drill water to offshore supply vessels.

2.2.3. Pilotage

Port Authorities Regulations 2001 provide that pilotage is compulsory for all vessels of 150 gross tonnes or more that are entering, leaving or manoeuvring within the Port unless exempted from doing so. This is an operational control measure within a risk management framework, which mitigates the risk of potential environmental pollution. BrPA licences a third party to provide pilot launch services in support of pilotage operations (see section 2.3.3).

2.2.4. Navigation Aids

Navigation aids, which are the property of the Port, are one of the primary aids to safe shipping in confined waters. To meet its obligations under the *Port Authorities Act 1999,* BrPA must ensure that the navigation aids reduce risk, meet mariners' requirements and are maintained and operated to the required International Association of Marine Aids to Navigation and Lighthouse Authorities standards.

Minor repair and maintenance is done by BrPA either in situ or within the workshop. Annual inspections (above and below water), major servicing and maintenance work, such as sandblasting and painting, are conducted by contractors.

2.2.5. Anchorages, Moorings and Cyclone Contingency Plans

Port of Broome waters are gazetted mooring areas and all moorings are allocated and controlled by BrPA. Approval must be obtained from BrPA before moorings are installed and all moorings must be inspected annually by approved mooring inspectors. There are three main mooring areas: Gantheaume Point, Inner Harbour and Black Ledge (cyclone moorings for small vessels). All moorings at these areas are privately owned.

There are five charted anchorage areas for vessels within Port waters: Inner Harbour (small/local vessels less than 50 metres in length), Outer Anchorages, Gantheaume Point Anchorages, Entrance Point Anchorages and Roebuck Bay Anchorages. Anchorage locations are specified on navigation charts AUS50 and AUS51.

Vessels must have their own cyclone contingency plans. However, in all circumstances, the decisions of the Harbour Master in relation to cyclone response take precedence. BrPA has developed a Cyclone Contingency Plan within its Emergency Response Plan (ERP), designed to

assist the Harbour Master and the owners and masters of vessels. Neither the wharf nor anchorages within the Port of Broome constitute a safe haven for ships or boats.

2.2.6. Communications

BrPA maintains a Radio Communication System within the Port to monitor port activities and to ensure all vessels adhere to the operating and communication procedures. VHF Channel 14 is used as the normal radio traffic control channel but contact is initiated on the distress channel, VHF Channel 16, at all times except during port closure.

2.2.7. Shipping Channels

The Inner Anchorage is a natural deepwater channel in which depths are maintained by the strong tidal currents. As such, no channel maintenance work (e.g. dredging) is required. BrPA is required to sound channel depths on a regular basis to ensure declared depths are maintained and this is accomplished through annual Department of Transport hydrographical surveys. Additionally, the pilot sounds the channel during each pilotage movement (BrPA 2000b). A survey of the outer approaches to the port has been scheduled for 2013 and resides within the Hydroscheme, managed by the Hydrographer Royal Australian Navy.

2.2.8. Tugs and Towage

A tug is compulsory for berthing or departure operations at the Port at Pilot's discretion and this is predicated on the size and manoeuvrability of the vessel, and prevailing weather conditions. Towage guidelines for the port are contained within the BrPA Port and Terminal Handbook. One tug is based in Broome and operated by Broome Marine and Tug Pty Ltd. If a second tug is required for a particular ship, it must be sourced from another port by the towage provider. The pilot launch Kestrel can be used for line boat, security and search and rescue purposes as deemed necessary. Vessels used to maintain navigation facilities are contracted on a needs basis.

2.2.9. Berth and Jetty Infrastructure

BrPA is responsible for ensuring that all berthing and jetty infrastructure is maintained in good working order. The steel piled jetty has a concrete deck and spring fenders with an outer berth of 331 m length that is used by supply vessels, livestock ships, general cargo ships, petroleum tankers and cruise liners. The inner berth consists of two separated lengths of 170 m and 96 m that provide for supply vessels, smaller naval and commercial vessels.

Most jetty maintenance work is undertaken by BrPA, either in situ or following removal of items to its maintenance yard or facilities off site. Activities include welding, metal fabrication, general repairs, cleaning and painting. Both BrPA and contractors conduct major maintenance work refurbishment of protective coatings on jetty piles and beams, and upgrade the fender system as required.

BrPA also conducts upgrade and improvement works to the wharf and its facilities from time to time. Recent and/or current projects include:

a) demolition of lumpers mess building at end of jetty neck and replacement of decking;
b) wharf extension of life project, which aims to extend the original 50-year lifespan of the 1960s-era wharf by another 10 years;

c) partial demolition of the transit shed (leaving the stevedores' messing facilities intact) to increase operational area on the wharf decking; and
d) installation of additional multistage landings at inner berths 1, 3, 4 and 12 (similar in design to the existing multistage landing at berth 11) to increase flexibility for the berthing of smaller vessels.

2.2.10. Water Supply and Bunkering Services

Water is available at the jetty via nine standard water outlets plus four high volume outlets which can supply potable water at rates up to 120 tonnes per hour. Operation of the low volume water supply outlets is undertaken by the vessel or its local agent, while the high volume outlets are operated by BrPA staff.

Five fuelling bowsers plus ten high volume fuel outlets are available on the jetty. The high volume outlets can supply fuel at rates of up to 80 tonnes per hour. All fuel bunkering activities are the responsibility of the fuel suppliers and must be carried out in accordance with the management procedures detailed in section 5. BrPA maintains a Bunkering Permit System which must be completed for any vessel taking fuel bunkers.

2.2.11. Cargo Handling

BrPA provides stevedoring services to visiting vessels. The stevedores are trained to assist ship personnel with loading and unloading cargoes including:

a) general cargo;
b) livestock and livestock fodder;
c) bulk products from road tankers onto ships;
d) liquid drilling mud, bulk barites, bentonite and cement for offshore supply vessels;
e) drilling equipment and supplies for offshore supply vessels;
f) containers;
g) bitumen; and
h) liquid petroleum products.

Spillages during the unloading or loading of the various livestock and liquid and dry bulk cargos are controlled as follows:

Livestock

Manure and fodder deposited on the jetty deck during vessel loading is manually shovelled into bins by the stevedore workforce. A drive-on mobile scrubber machine is available for cleaning dusty residues. Similarly, deposits on land are cleaned away, with all land and wharf residues disposed of by a licensed waste contractor.

Liquid bulk petroleum products

Continuous monitoring of hoses and connections is conducted by the fuel supplier in accordance with articles 34 and 35 of BrPA's Marine Safety Plan (MSP). Collapsible transportable bunds and drum bunds are to be utilised in the event of any spill or leakage on the wharf or on land. High performance oil spill recovery kits are located on the wharf and in the maintenance yard. An absorbent boom is trailer mounted for transport to an oil spill control site within the Port areas of

responsibility. The port retains oil spill equipment from the state stockpile provided by the Department of Transport.

Dry bulk cargos (including cement, barites etc.)

Procedures are listed in Article 37 of the MSP.

2.2.12. Waste Oil Collection

To encourage environmentally responsible collection, treatment and disposal of waste oil, BrPA provides a waste oil collection service for small vessels using the jetty. An internally bunded storage shed equipped with a roller door is located on the jetty for placement of waste oil drums (mostly 20 L drums). Waste oil is periodically collected and disposed of by a licensed waste carrier.

BrPA has purchased a waste oil tank with the intention to install it in the maintenance yard. When installed, waste oil will be decanted into the tank instead of being stored in drums on bunded pallets. A licensed waste services provider will be periodically contracted to pump out the tank and dispose of the waste oil when the tank is nearing capacity.

2.2.13. Machinery Maintenance

General cleaning and maintenance of onsite heavy machinery (i.e. three mobile cranes with capacities of 45 t, 100 t and 250 t) is conducted within the maintenance yard. The majority of metal fabrications and welding work is conducted under cover and over a paved surface. Vehicle cleaning is conducted over a heavy duty rubber sheeted area and any oily residue is scraped up and disposed of correctly. Hazardous goods are stored inside the workshop in a flame proof cabinet with Material Safety Data Sheets.

The maintenance yard is also used to store general port items such as gangways, spare navigation aids, old timber piles and fender rubbers, rope, timber, wire, steel, paint, epoxy coatings, lubricants, oils and rubber. The majority of chemicals (paint, oil and epoxy coating) are stored within the small internally bunded shed, and drums of lubricants, paint and epoxy coating are stockpiled in the yard in heavy duty polyethylene drum bunds.

2.2.14. Land Clearing

From time to time, BrPA may require to clear native vegetation on land managed by BrPA for the purposes of establishing additional operational facilities. In general these facilities will be provided for the use of BrPA tenants and may include the following:

a) warehousing and container laydown areas;
b) logistic transport nodes;
c) storage areas for drilling equipment, general stores, casing and pipe;
d) storage areas for sundry equipment used by oil rigs and their supply vessels, including (but not limited to) chain, anchors, drill casings, drills, safety equipment, chemicals and small amounts of explosives;
e) repair and maintenance workshops; and
f) administration offices.

Development of these areas will involve the clearing of vegetation and the potential loss of some flora and vegetation of conservation significance and indigenous heritage.

2.2.15. Establishment and Maintenance of Environmentally and Culturally Sensitive Areas

In order to ameliorate the effects of clearing native vegetation, BrPA has established three environmental and culturally sensitive areas within which no clearing will occur. These areas will be actively managed by BrPA for the protection of environmental and cultural values. The location of the areas is shown on Figure 1.

2.3. Port Related Activities Undertaken by Other Parties

A number of port related activities and services are managed by parties other than BrPA. Those that have the potential to impact upon the environment within, or in the vicinity of the PMA, are discussed in detail below.

2.3.1. Ship Waste Management

Solid waste generated aboard small vessels is placed in skip bins located on the jetty after vessels have berthed. The bins are supplied and collected by Toxfree, which transports them to the local landfill for disposal. There is no waste stream separation, the bins are not locked and there is no supervision of what is disposed into the bins. However, the bins are provided with lids to prevent wind-assisted escape of waste and access to waste by birds.

The reception and disposal of quarantine waste from vessels arriving from overseas ports is managed by the Department of Agriculture. Reception of quarantine waste is for international voyage ships only and is generally discouraged as there is no accredited quarantine waste operator in the Broome area. Broome Port handles quarantine waste upon special request only (approximately four to five ships per year). The waste is double bagged on board the vessel and disposed of at the jetty in specially pre-arranged skip bins, which are sourced from Kimberley Waste. Upon collection of the skip bins, a Department of Agriculture inspector follows the truck to the local landfill to ensure that the waste is immediately buried in an approved manner. An incinerator is located in Port Hedland if this is deemed necessary by the Department of Agriculture.

Ballast water management is discussed in section 5.1.11.

2.3.2. Quarantine Inspections

All international traffic entering Broome Port is inspected by the Department of Agriculture. The Department of Agriculture inspector will board once the vessel has come alongside the wharf. Matters addressed by the inspector include:

a) checking reporting forms and vessel log books relating to previous ballast water uptake, exchange and any intended discharge;
b) health of persons onboard;
c) presence of pets, vermin, bees and other insects or birds;
d) general ship hygiene;
e) meat, fruit and other stores;

f) waste storage;

g) cargo;

h) health of previously loaded livestock, if any; and

i) livestock husbandry systems, including wash-down and cleaning procedures.

If a significant problem is found, the inspector will quarantine the vessel and manage the issue according to Department of Agriculture Work Instructions. This can include refusing its entry until the vessel has been properly washed down (e.g. in the case of livestock carriers), or fumigation if pest infestations have been found, or a contagious disease clearance (in the case of crew or passenger illness). If ballast water carried by an overseas arrival had not been exchanged during the voyage in accordance with current Australian regulations, the vessel can be refused permission to discharge ballast water whilst loading, although ballast discharge is not normally conducted by vessels in Broome.

2.3.3. Pilotage

BrPA licenses Kimberley Pilotage Group to provide pilotage services for all vessels requiring pilotage in and out of the Port of Broome.

2.3.4. Vessel Maintenance

Vessel maintenance activities on land are not directly carried out by BrPA. However, vessel maintenance is conducted at the slipway located along the eastern foreshore of the site.

The slipway area is generally unpaved with the exception of a concrete hardstand in the centre. BrPA provides a waste skip for general refuse generated by slipway area users, with signage to indicate that other types of waste (e.g. used oil) are not to be disposed of in the skip.

Users of slipway wishing to conduct vessel maintenance of any description (including hull cleaning) are required to obtain a permit to work from the BrPA operations office before commencing work.

The ongoing management, operation and improvement of the slipway is complicated by the Department of Transport's proposal to construct an all-weather and all-tide public boating facility adjacent to the current location of the slipway. Construction of the public boating facility is scheduled to begin in 2014/2015. In the interim, BrPA remains responsible for the management of the slipway and maintenance area and is currently reviewing the continued operation and management of these facilities.

Limited vessel maintenance work is carried out on vessels moored at the wharf.

2.3.5. Traffic Management

Principal vehicular thoroughfares within the PMA are the responsibility of Main Roads Western Australia (MRWA) and/or the Shire of Broome.

With increasing development in the northern part of the PMA, BrPA is currently in discussions with MRWA about assuming responsibility for the management of Port Drive. This would allow BrPA to address traffic management (e.g. setting of appropriate speed limits) and other infrastructure issues related to the road reserve (e.g. stormwater management) in a way that more closely matches BrPA's objectives for land use in the PMA.

2.4. Other Activities Undertaken by Tenants or Contractors

Various other activities that are undertaken by tenants within the Port area are described below.

2.4.1.Fuel Tank Farms

Approximately 7 ha of Port land are leased to Shell Australia Ltd (Shell) and BP Australia Ltd (BP) for the storage and distribution of bulk fuel products. The tank farm area is located along the south-western side of Port Drive (Figure 1). Records indicate that the area has been used as a fuel tank farm since the 1970s. In early 2009, as part of the Port's environmental monitoring program, comprehensive test bores in the vicinity of the farms confirmed that no underground seepage has occurred. However, the former Department of Environment and Conservation (DEC) (now Department of Environment Regulation (DER)) since advised that there has been some minor fuel leakage into the water table, placing a memorial on the title requiring that it be remediated. Three additional monitoring wells are also being drilled by BP as part of their environmental management processes.

A brief overview of key activities at each installation is provided below.

BP/Reliance Petroleum

BP first took a lease on the site in 1983. Prior to 1983, the area now leased to BP was leased to a Shell fuel agency and prior to that it was part of the former quarantine station. BP still owns the infrastructure located on the facility and supplies fuel products. However, management of distribution operations was taken over by West Kimberley Fuels in 1989. Fuel distribution is now managed by Reliance Petroleum.

Site equipment includes:

a) office and amenities buildings;
b) lube oil drum storage;
c) drum platform;
d) vehicle filling gantry;
e) water tank;
f) foam tank; and
g) six aboveground storage tanks (ASTs) and associated pipework.

This site includes a bunded AST, loading manifold, oil water separator and two holding ponds.

Wastewater generated onsite is controlled in the following manner:

a) condensate water from BP tanks and wastewater generated during tank cleaning is treated through a centrifugal "Spinifex" oil water separation system located within the lease area. Fuel product is separated, collected and stored in waste oil drums. Separated 'clean' water goes to a holding/evaporation pond; and
b) condensate water and wastewater generated during cleaning of the Kimberley Oil tank passes through an old oil water separator to the drainage ponds located along the western boundary.

Stormwater control measures are in place including:

a) stormwater generated around the loading gantry is collected within a bund and piped to a holding sump. The sump is pumped out by a Kimberley Waste truck or decanted into drums as required, with keys to the bund drain valves held by two senior managers only; and
b) all tanks are surrounded with a bund capable of holding, at a minimum, the tank's contents plus 10%.

During exceptional rainfall events, stormwater can sheet flow overland off the site, transporting sediment and potentially oil contaminated water toward Roebuck Bay. For this reason considerable care is taken to keep these sites clean and the Port commissions an independent environmental audit on an occasional basis to ensure this practice with both all fuel and bitumen suppliers' premises.

Shell

Shell's lease area is separated into three separate operational units: a fuel depot, fuel terminal and bitumen plant. The distribution of Shell products is coordinated through the depot, including supply of diesel to the jetty. Bulk storage of product is managed at the terminal. Bulk storage of bitumen is managed at the bitumen plant.

Fuel Depot

Equipment located within the depot includes:

a) office and amenities sheds;
b) diesel underground storage tank (UST);
c) diesel bowser;
d) storage shed (minor volumes of aviation fuel);
e) oil water interceptor; and
f) drum storage area.

Some stormwater controls are in place including direction of stormwater generated within the drum storage area through a below ground oil-water interceptor. The diesel bowser is bunded and stormwater generated within the bund will also be directed through the interceptor. In the event of extreme rainfall, stormwater from the depot could move overland as sheet flow toward the BP site and ultimately into Roebuck Bay. For this reason considerable care is taken to keep these sites clean and the port commissions an independent environmental audit on an occasional basis to ensure this practice with both all fuel and bitumen suppliers' premises.

Fuel Terminal

The fuel terminal, which was built in the late 1980s, comprises:

a) office and amenities sheds;
b) loading gantry;
c) two large storage tanks and associated pipework;
d) three smaller ASTs;

e) oil water interceptor; and

f) evaporation channel.

Condensate from the tanks plus any stormwater collected from around the loading gantry is treated through an oil-water interceptor. Recovered product is held in a below ground sump which is pumped out as required. The water fraction is piped to a long narrow evaporation channel. Contractors clean the tanks once every 10 years and they are responsible for wastewater management.

All tanks within the terminal are surrounded by a high bund with a holding capacity in excess of the required minimum 10% of volume stored. Clean stormwater is diverted around the tank farm and discharged to the surface to the north of the lease area. It is understood that this water merges with runoff from the Aquaculture Park and discharges through the coastal dunes to Riddell Beach. BrPA is currently developing a local water management strategy, which includes a stormwater management plan, to address ongoing stormwater management in the PMA.

Bitumen Plant

The bitumen plant, which commenced operation in the early 1970s, comprises:

a) three gas cylinders;

b) heating equipment;

c) above ground bitumen storage tank;

d) loading gantry; and

e) former slops dip.

The tank is surrounded by a small bund in keeping with the very low viscosity properties of bitumen, however there are no other stormwater controls onsite. In the event of extreme rainfall, stormwater from the bitumen plant could move overland as sheet flow toward Roebuck Bay. For this reason considerable care is taken to keep these sites clean and the Port commissions an independent environmental audit on an occasional basis to ensure this practice with both all fuel and bitumen suppliers' premises.

The bitumen plant has been out of use since about 2010, by which time Shell had switched to transporting bitumen into Broome using road trains.

2.4.2. Aquaculture Park

Approximately 8 ha of Port land located along the western side of Port Drive has been designated as an aquaculture park (Figure 1). The land was leased to the Department of Fisheries (Fisheries) in 1996. Fisheries has subsequently sub-let parcels primarily to the Kimberley College of TAFE and Paspaley Pearls.

Fisheries has an obligation under its sub-lease agreements with aquaculture park tenants to supply unfiltered seawater. Pumping facilities are located on the jetty and seawater is drawn from immediately below the jetty pump shed. This water is piped to a 150 kL storage tank located at the southern end of the aquaculture lease. From this tank the tenants draw their required water. Fisheries monitor intake seawater quality on a quarterly basis for a range of parameters. To

supplement water supply, a saline groundwater bore was installed by Fisheries within Port lands. The bore water quality is monitored by Fisheries on a quarterly basis.

Return water is piped from the various aquaculture facilities back to the jetty where it is discharged immediately beneath the jetty. Fisheries' sub-tenants are responsible for treating their own waste water to ensure it complies with the relevant environmental standards, and the conditions of their aquaculture/pearling licences.

Spills within the aquaculture facilities and chemicals used in cleaning of recirculation filters have the potential to enter the return water system. Chemicals used include hydrochloric acid, detergents and chlorine. Concern may arise as the return water discharges to Roebuck Bay. As previously noted, Fisheries monitors the return water quality on a quarterly basis and Fisheries' sub-tenants are also required to comply with relevant environmental legislation.

There is no overall stormwater control plan in place for the park. Each tenant has installed certain stormwater control devices to control run-on and run-off on their lot. Stormwater generated in the park is absorbed into the ground until saturation point is reached at which time it flows overland toward Reddell Beach and discharges through the coastal dunes. This may be a contributing factor to gully erosion at points along Reddell Beach.

Fisheries sub-tenants are licensed under the *Fish Resources Management Act 1994* or *Pearling Act 1990.* They are also required to meet the conditions of their lease and the conditions specified in their aquaculture or pearling licence.

Kimberley Training Institute

Kimberley Training Institute (formerly Kimberley College of TAFE) operates a training facility that includes a hatchery for tiger prawns and barramundi and an algal culture laboratory on Lot 506. The hatchery uses water sourced from the saline groundwater bore. The hatchery has both water recirculation and flow through systems in their tanks. Backwash water (from the recirculation system filters), general washdown water and flow through water passes through a sand filter prior to being discharged via the Fisheries return water pipeline.

Ocean and Earth Training

Ocean and Earth Training leases Lot 507 from the Department of Fisheries, providing specialist training relevant to the maritime, mining, building, construction, tourism, hospitality, agricultural, sport and recreation industries, including to BrPA employees and contractors.

Lot 507 and the facilities on it were previously leased by Manbana, which operated a multispecies aquaculture hatchery designed for training indigenous people. The facility uses seawater but has low water usage as most tanks operate on a recirculation system. Backwash water (from the recirculation system filters), general washdown water and minor amounts of flow through water pass through a sand filter prior to being discharged via the common Fisheries discharge pipeline.

Ocean and Earth is currently using only the sheds, offices and yards on the site. The aquaculture infrastructure is not currently in use. Ocean and Earth is advertising for the sub-letting of the aquaculture facilities.

Paspaley Pearls

Paspaley Pearls operates a commercial pearl oyster hatchery at the northern end of the aquaculture park on Lot 512. The facility is operated to meet the conditions of their pearling licence, the Pearl Oyster Fishery Ministerial Policy Guidelines and the Pearling Industry Translocation Protocol. Paspaley has an internal Hatchery Operations Manual which incorporates these requirements and a Disease Contingency Plan. The facility is inspected on an as-needs basis by a Fisheries officer for matters such as procedures, filters and water pathology.

The facility operates on a full flow through system. Intake water is monitored daily for salinity, temperature and dissolved oxygen. Discharge water is sand filtered prior to discharge via the return saline water pipeline that runs along the back of the Fisheries lots.

2.4.3. Oilfield Transport Services

Oilfield Transport Services (OTS) occupies Lot 514 on the eastern side of Port Drive at the northern end of the PMA (Figure 1). OTS recently sub-let the northern part of Lot 514 to Toll Mermaid Logistics Broome Pty Ltd (TMLB). TMLB has entered into arrangements to divide its portion into two for the use of its customers, with one part for the use of TMLB as Supply Base No. 3 and the other part for the use of TMLB's customer, Inpex.

Lot 514 is approximately 7.1 ha. All three parts of it – OTS, Inpex and Shell, from south to north – consist of various laydown areas, office buildings, amenities and storage sheds. The TMLB leased portion is mostly paved hardstand, with the OTS portion unsealed but about three-quarters covered in metal sheeting.

Stormwater runoff from the Shell and Inpex lots is directed overland to a soak-away basin located at the northeast corner of the site, which is leased from the Port of Broome to the Shire of Broome. It is understood that the holding basin adequately contains all runoff. Stormwater from the OTS yard flows in the direction of Port Drive.

OTS allows the storage of large volumes of drilling fluids onsite for its customers. However, there is no fuel storage onsite. There is also no history of arsenic cattle dip use on site. A truck based sprinkler system is in place for dust suppression.

This area was previously utilised as cattle yards with a feed lot capacity of 4,500 head. Stockyards occupied the site for approximately six years during this time. The site was previously a market garden and prior to that the grounds of a nunnery.

2.4.4. Toll Mermaid Offshore Supply Bases

Toll Mermaid Logistics Broome Pty Ltd (TMLB) currently operates three sites in the PMA, all of which are used as supply bases for servicing the offshore oil and gas industry.

Supply Base No. 1

Supply Base No. 1 is situated on Lot 549 between Port Drive and Murakami Road. The premises contain a new facility that was constructed by TMLB in 2012. Onsite facilities include perimeter security fencing, a large laydown area, four enclosed storage sheds, administration offices, vehicle parking and an unlined stormwater drainage pit. The majority of the site is paved hardstand.

Supply Base No. 2

Supply Base No. 2 is located at the southern end of the PMA, on Lots 536, 537, 538 and 550 between the fishing club and BrPA administration buildings (Figure 1). The lease area comprises a large storage shed, several relocatable site/office sheds and a large, fenced and paved outdoor storage area. The site also contains a disused bulk grain silo and conveyor system. The lease area was first awarded to TMLB on 5 February 2009. It has been used for temporary storage of packaged goods prior to them being shipped to offshore oil and gas rigs. The area had been previously leased to Brambles for storage of explosive materials.

The outdoor area is mostly used to store drill tubes and innocuous materials such as timber, steel, tyres and sea containers. Drums of caustic waste and waste oils generated on the offshore rigs are also received at the base. These are sent to Port Hedland for disposal. Goods stored within the shed may include explosives, radioactive materials such as well logging tools, bentonite, barite, wire, pumps, pipes, chemicals, steel and bricks. Any spill within the shed would be contained within the shed and not impact external surface water.

No surface water controls were observed. It appears that runoff generated outside the shed flows overland toward the jetty and Roebuck Bay. Wastewater (sewer) is collected in holding tanks that are pumped out and tankered offsite for disposal as required.

Supply Base No. 3

Supply Base No. 3 is sub-let from Oilfield Transport Services' Lot 514 lease holding on the eastern side of Port Drive at the northern boundary of the PMA.

Half of this area is predominantly paved hardstand and is being used as longer-term storage for casing and offshore drill rig equipment for Shell.

The other half of this area has been recently constructed for Inpex. It is due to open in September 2013. The Inpex area contains an office building, two storage sheds, one dangerous goods storage shed, casing cleaning and washdown station, casing storage and loading/unloading area. The entire area is paved hardstand.

Access to both the Shell/Supply Base No. 3 area and the Inpex area is via a common gated entrance from Port Drive, with shared light vehicle parking facilities inside the gate for staff of and visitors to both facilities.

2.4.5. Hovercraft Base

A hovercraft base is located on the eastern foreshore of the Port with two hovercraft, a large shed for housing the craft, indoor diesel tank, semi-enclosed workshop, tearoom, outdoor function centre and ablution amenities. It is understood the site has been used for these purposes since 1988.

The majority of hovercraft maintenance, repair and refuelling activities are conducted onsite. Materials and chemicals used are stored within the main shed or the workshop at the rear of this building. Diesel is stored in a 2,000 L tank situated on a platform inside the main shed. The floor is paved; however the tank is not bunded. Diesel is tankered in from the nearby BP Depot. Waste oil is contained within drums that are stored at the rear of the site. This area is uncovered, unpaved and unbunded. The drums are shipped offsite when necessary.

Stormwater onsite appears well controlled and efforts have been made to reduce erosion potential by paving slopes and providing grassed/vegetated areas for runoff dissipation.

Wastewater is contained within two septic tanks at the rear of the site. Leach drain pass along the rear of the property toward Roebuck Bay.

The main noise source of a hovercraft is from the fans while the craft is in motion. This is mitigated through installation of cowling around the fan and a lining of noise reducing foam inside the cowling.

2.4.6. Slipway

Broome Slipway is located along the eastern shore of the Port, approximately 300 m northwest of the jetty (Figure 1). The site, formerly managed by Mermaid Marine, was historically used as a barge landing site for Woodside Fuel (1968 to 1983), then as a boat repair yard (post 1986) including slipway, traction shed and general workshop. All major infrastructure has since been removed. It is understood that maintenance activities historically conducted included grit blasting, metal fabrication, welding, painting, anti fouling and general ship repair.

There is a history of uncontrolled landfilling along the foreshore of the lease area, which was subject to a preliminary site investigation conducted by Egis Consulting in 2000. As discussed in section 2.3.4, a public boating facility has been proposed for the area adjacent to the slipway. In the meantime, BrPA has permit systems in place for managing the activities of slipway users.

2.4.7. Fishing Club

A small parcel of land (Lot 539) located near Beacon Hill is leased to Broome Fishing Club. This land contains a clubhouse, ablutions, car park, waste skip, caravan and fenced yard. Landfilling is a permitted activity under the lease with BrPA, whereby the Fishing Club has advised that clean fill and gravel has been used to level the site.

2.4.8. Public Boat Ramps

Two public boat ramps are located at the southern end of the peninsula (Entrance Point). Broome Port is responsible for their maintenance. The Shire of Broome provides waste bins and waste collection.

A proposed public boating facility is discussed in section 2.3.4.

2.4.9. Solid Waste Management

General solid waste generated at BrPA's administration building and by the various tenants is placed in 240 L mobile garbage bins that are emptied by the Shire. Individual tenants are responsible for any waste management requirements in addition to that provided by the Shire.

3. DESCRIPTION OF THE EXISTING ENVIRONMENT

This section provides an overview of the existing receiving environment. It is described in terms of the regional setting, physical environment, ecological features and socioeconomic features. Each activity performed within the PMA has the potential to impact upon various features of the receiving environment, and as such it is important to have a thorough understanding of all potential pathways prior to assessing environmental impacts.

3.1. Regional Setting

The Port of Broome is located 2,200 km north of Perth in the Kimberley region. The region has an area of 421,000 km^2 and is surrounded by the Indian Ocean to the west, Timor Sea to the north, and the Great Sandy and Tanami Deserts to the south and east. The resident population is only 33,700, making the Kimberley a sparsely populated area. The bulk of the population is centred around port towns and mining areas (URS 2003).

The Kimberley region makes a significant contribution to Western Australia's economy by providing some of the State's most valuable exports, including diamonds, pearls, gold, lead-zinc, nickel and platinum. It is also the location of significant beef production, oil and gas reserves and is a popular tourism destination.

The Kimberley's diverse landscape encompasses rugged ranges, gorges, waterfalls and cave systems, pockets of rainforest, sandy beaches and deserts. Aboriginal people have lived in the region for more than 40,000 years, resulting in a rich legacy of rock art and places of cultural significance. The Kimberley also features a number of significant national parks.

3.2. Physical Environment

3.2.1. Climate

The Kimberley is located within the tropical zone where the climate is characterised by dry winter seasons (April to October) and wet summer seasons (November to March). The area experiences summer monsoonal rains, and cyclones occurring in the region about once every 1-2 years. Average annual rainfall in Broome is approximately 600 mm, falling on average over 61 rainy days a year. Rain intensity may be high when associated with cyclone activity and may cause flooding.

3.2.2. Geomorphology, Topography and Drainage

The Broome area is characterised by a gently undulating plain of red sandstone terminating at the coast as either exposed cliffs 1–10 m high, or covered by more recent Quaternary sediments. These sediments consist of dune, beach and tidal flat deposits of either Pleistocene or Holocene age. Underlying all of the above units is the Cretaceous Broome Sandstone which outcrops as cliffs at Gantheaume Point, Entrance Point and east of Dampier Creek. A layer approximately one metre thick of laterised cobbles and Pindan clay has formed between the Broome sandstone and Pindan units.

The geological characteristics of the PMA generally comprise flat Pindan plains (composed of red aeolian sands and clays), high relief Pleistocene dunes overlaying the Pindan unit by up to 10 m in places. The eastern boundary of the port is characterised by a Holocene dunal system which provides an important and fragile interface between the marine and terrestrial environments.

The main natural drainage line flows in a southwesterly direction through two known outlets onto Riddell Beach. This catchment collects runoff generated around the tank farms and the Aquaculture Park. The outlets have been eroded through foredunes and are sites of considerable gully erosion. Localised runoff generated at the administration area, offshore supply base, slipway, public boat ramp and hovercraft base drains toward Roebuck Bay.

3.2.3. Predominant Shorelines

The shoreline on the seaward side of the peninsula (from Entrance Point westward toward Gantheaume Point) alternates between sandstone cliffs and headlands with intertidal sandstone shelves, and sandy beaches between these headlands. The shoreline on the bay side of the peninsula (from Entrance Point eastward toward the Broome townsite) comprises a long curving sandy beach and sandy/silty tidal flats.

3.2.4. Bathymetry

The bathymetry on the seaward side of the peninsula is characterised by relatively gently sloping rocky, sandy or muddy tidal flats at the low water mark that drop rapidly at the 1-2 m contour, denoting a deep water channel known as Roebuck Deep. The bathymetric contours, and consequently the channel, run approximately parallel to the coastline. The channel has a northwest to southeast alignment and is up to 96 m deep. To the south of the peninsula is another channel known as the Inner Anchorage which branches off Roebuck Deep. It is aligned southwest to northeast and is up to 25 m deep. Broome jetty is located within the Inner Anchorage near the junction with Roebuck Deep. The bathymetry in the immediate vicinity of the jetty changes rapidly at the 2 m contour, dropping away to a depth of 15 m.

3.2.5. Oceanography and Coastal Processes

Tides within the Port of Broome are predominantly semi-diurnal. The tidal range is large with the predicted astronomical tide variance from about 0.06 m to 10.56 m above chart datum (lowest astronomical tide). A typical spring tide range is from about 1.54 m at low water to 9.28 m at high water. Given the large tidal range, significant tidal currents occur in Roebuck Deep and the Inner Anchorage.

Spring tide currents in the vicinity of the jetty have been measured at around 3–5 knots. There is a considerable reduction in current speed where water depths decrease in the Inner Anchorage and over the tidal flats. The ebb and flood flows are generally parallel to the shore (LeProvost Environmental Consultants 1990) but do exhibit some variation.

The local wave climate is influenced by the effects of tide and seasonal winds acting on a predominantly westerly swell regime. Swells are generally low to moderate in winter and low in summer except during cyclonic events. Short period wind-waves are typically generated by light east to southeasterly breezes which predominate in winter. While light winter breezes produce a low wave climate, strong easterly winds can blow for considerable periods (several days or more), generating moderate to rough seas.

Coastline studies show that the seaward side of Dampier Peninsula is slowly eroding, with Reddell Beach eroding at an average historical rate of 20 cm/year (Department of Planning and Urban Development 1990). Other investigations have shown that the shoreline facing Roebuck Bay is also slowly eroding (10 cm/year; LeProvost Environmental Consultants 1990). Evidence that erosion is

the dominant coastal process in the port area is the beach rock exposures at the toe of the beaches and lack of foredune development. While shoreline sediment transport rates are generally low due to the mild wave climate, large swell events from periodic cyclones can mobilise and transport considerable amounts of beach sediment.

The influence of large tidal movements mobilises and maintains a high level of suspended fine seafloor sediments in Roebuck Bay, resulting in high turbidity levels that reduce only at neaps. Salinities in Roebuck Bay typically vary from about 35 ppt in summer to 37 ppt in winter, with lower surface salinities occurring whenever there is substantial freshwater input during the summer monsoonal season. Seawater temperatures regularly exceed 30ºC in summer and decline to minima of around 22ºC in winter (URS 2003), with the highest maxima and lowest minima occurring in the shallower areas of Roebuck Bay.

3.3. Coastal Ecosystems and Biological Communities

3.3.1. Terrestrial Communities

Terrestrial Plants

Vegetation

Plant communities in the PMA and surrounds have been surveyed and described by LeProvost Environmental Consultants (1990) and Woodman Environmental Consulting (2008, 2009). Additional site inspections have been undertaken by Coffey Environments (2013a, b).

Floristic groups across the Broome Peninsula appear to respond to a combination of soil (pindan versus coastal sand dune), hydrological (dune crest versus dune base) and climatic (inland verus coastal) factors.

Woodman Environmental Consulting (2008) described six different floristic community types (FCTs) on the southern end of the Broome Peninsula, four of which occur within the PMA (FCTs 1, 2, 3 and 4).

FCT 4 dominates the PMA and is described as an open woodland of mixed *Corymbia* spp., *Hakea macrocarpa* and *Persoonia falcate* over shrubland dominated by *Acacia colei* var. *colei* over grassland dominated by *Triodia pungens* and *Triodia acutispicula* on orange to red pindan soils on lower to upperslope positions.

FCT 1 is described as shrubland dominated by *Acacia bivenosa* and *Crotalaria cunninghammii* subsp. *cunninghammii* with occasional *Bauhinia cunninghammii* and *Santalum lanceolatum* over grassland dominated by *Spinifex longifolius* on pale brown sand on foredues and on the leeward side of foredunes. This FCT occurs predominately on the southern and western coastal edge of the PMA.

FCT 2 is described as an open woodland of *Corymbia polycarpa* over open shrubland dominated by *Crotalaria cunninghamii* subsp. *cunninghamii* and *Tephrosia rosea* var. *rosea* over grassland dominated by *Triodia acutispicula* and Poaceae sp. on orange sand on secondary dunes. This FCT occurs primarily on the eastern coastal edge of the PMA.

FCT 3 is described as an open woodland of mixed species including *Bauhinia cunninghammii* and *Terminalia petiolaris* over occasional shrubland dominated by *Acacia bivenosa* over lower shrubland

of mixed species including *Tephrosia rosea* var. *rosea*, *Euphorbia coghlanii* and *Abrus precatorius* subsp. *precatorius* on pale orange to brown sand on lower slopes behind dunes and secondary dunes. This FCT occurs primarily on the southern coastal edge of the PMA.

One Priority Ecological Community (PEC) is known to occur in the PMA. The 'Relict dune system dominated by extensive stands of Mangarr' PEC was gazetted as a Priority 1 PEC in May 2012. The PEC is dominated by *Sersalisia sericea* (formerly *Pouteria sericea* and otherwise known as Mangarr), which has been found in two areas of the PMA, both west of Port Drive (Environs Kimberley and SKIPA 2011, Coffey Environments 2013b).

Mangarr is described as a shrub or tree growing to heights ranging from 1 to 15 m. Mangarr produces cream to yellow flowers all year round. Mangarr individuals and populations are known to occur in sandy soils over sandstone or basalt and along watercourses. The stands of Mangarr within the amendment area occur in association with species more commonly encountered within the nearby Monsoon Vine Thicket Threatened Ecological Community (TEC).

The Monsoon Vine Thicket TEC represents the most southerly rainforest type vegetation in Western Australia (DSEWPAC 2013). It is predominantly restricted to the Dampier Peninsula and is associated with Holocene sand dunes and other coastal geological formations. The TEC occurs as discontinuous patches of dense vegetation usually occurring on the leeward slopes and swales and sometimes the exposed crests of the coastal Holocene dune systems. Some patches may extend landward onto the red soil pindan plains. The canopy of the TEC is typically dominated by a mix of several tree or tall shrub species, including Goolnji, Ebony Wood, Mamajen, Mangarr, Gubinge and Blackberry Tree/Marool/Nawalu. The mid layer, when present, can contain semi-deciduous fruiting shrubs and small trees. The ground layer contains about 6 cm of organic matter and may have little cover where the canopy is intact. Vines and climber species may be present throughout all layers of the TEC. The relatively dense and closed nature of the TEC creates a shady and humid microclimate, with many species taking advantage of the abundance of fruiting species. Known locations of the Monsoon Vine Thicket TEC around Broome are to the north and northwest of the PMA. No occurrences of the TEC are known from within the PMA.

Flora

At least five conservation significant flora species are known or suspected to occur within the PMA, including *Keraudrenia exastia* (Threatened), *Goodenia byrnesii* (Priority 1), *Triodia acutispicula* (Priority 3) and *Phyllanthus aridus* (Priority 3). Initial floristic surveys identified a possible new taxon, *Scleria* sp.*,* although later surveys indicated that this taxon is already known and is not considered of conservation significance. The priority species have all have been recorded elsewhere on pindan soils within the region and are not presently at risk, while *K. exastia* has been recorded only on the Broome peninsula and at one inland location in the Great Sandy Desert.

Keraudrenia exastia (Fringed Keraudrenia) is a member of the Sterculiaceae family and is an erect, compact, multi-stemmed shrub that can grow to 0.9 m high. The flowers are purple and the flowering period is from April to December. The total known population of this species within the PMA is approcimately 21,000 individuals (Woodman, 2008). The species is list as critically endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and as declared rare flora under the *Wildlife Conservation Act 1950*.

A total of 14 introduced plant species (weeds) are also known to occur on the Dampier Peninsula. Such species include *Aerva javanica, Cenchrus ciliaris, Chloris barbata, Clitoria ternatea, Emilia*

sonchifolia, Hyptis suaveolens, Jatropha gossypifolia (bellyache bush), *Macroptilium atropurpureum, Merremia dissecta, Passiflora foetida* var. *hispida, Setaria verticillata, Sida cordifolia, Tridax procumbens* and *Ziziphus mauritiana* (Chinese date or Indian jujube). The weeds *Merrima dissecta*, *Passiflora foetida* var. *hispida* and *Setaria verticillata* are all known to occur in FCT 4 within the PMA (Woodman, 2008). *J. gossypifolia* (Category P4) and *Z. mauritiana* (Category P2) are declared plants under the *Biosecurity and Agriculture Management Act 2007*. However, neither is known to occur within the PMA.

Terrestrial Animals and Birds

Terrestrial fauna assemblages in the PMA and surrounds have been surveyed and described by McKenzie (1983), Gambold (1988), Wells (1988) and Bamford (2010).

The fauna of the Dampier Peninsula comprises a mix of animal groups from sub-humid tropical regions further to the north and arid to semi-arid regions to the south and east. As a result most fauna species are considered to be widespread across the Dampier Peninsula; with the greatest diversity occuring near the coast because of the wide range of habitats.

The main habitat types within the PBA and surrounds include pindan vegetation, thickets and large shrubs, open woodlands, coastal schrubland on primary dunes, tall dunes, mangrove communities, beaches and mud flats, and minor rocky headlands.

All fauna habitats are relatively widespread throughout the region, although thickets and mature trees (which contain hollows) of the species *Ficus aculeate* var*. indecora* are significant. This habitat provides roosting, sheltering and breeding locations for many bird, bats, pythons and arboreal mammals such as possums.

Based on database searches, the Dampier Peninsula has the potential to support up to 385 fauna species including 11 frogs, 82 reptiles, 255 birds and 37 mammals. Conservation significant species protected under Commonwealth or state legislation that are likely to occur within the PBA and surrounds include the Peregrine Falcon, Fork-tailed Swift, Rainbow Bee-eater, Barn Swallow and *Ctenotus angusticeps.* Other significant species include the Bush Stone-curlew, Northern Brush-tailed Possum, Northern Pipistrelle, Northern Blossom Bat, *Lerista separanda, Diporiphora pindan, Ctenotus colletti, Lerista apoda* and *Morethia storri.*

Rare visitors to the area protected under Commonwealth or state legislation include the Oriental Cuckoo, Grey Falcon, White-throated Needletail and Bilby.

Over forty species listed as migratory or marine under the EPBC Act have been recorded along the PMA and surrounding shoreline. The Broome region is recognised internationally for its migratory birdlife. A high diversity of bird species, many of which are migrant waders and vagrants that periodically arrive from the Northern Hemisphere (see Table 2 and section 3.3.2).

Table 2 Migratory bird species listed under the EPBC Act and known to occur on the Broome Peninsula

Common Name	Species Name	Records
Recorded by Birds Australia 2009		
Common Sandpiper	*Actitis hypoleucos*	Broome Port (many)

Common Name	Species Name	Records
Ruddy Turnstone	*Arenaria interpres*	Broome Port (many)
Sanderling	*Calidris alba*	Broome Port
Red Knot	*Calidris canutus*	Broome Port
Curlew Sandpiper	*Calidris ferruginea*	Broome Port (many)
Red-necked Stint	*Calidris ruficollis*	Broome Port (many)
Great Knot	*Calidris tenuirostris*	Broome Port (many)
Greater Sand Plover	*Charadrius leschenaultia*	Broome Port (many)
Lesser Sand Plover	*Charadrius mongolus*	Broome Port
Oriental Plover	*Charadrius veredus*	Broome
Oriental Pratincole	*Glareola maldivarum*	Entrance Point (Port)
Grey –tailed Tattler	*Heteroscelus brevipes*	Broome Port (many)
Broad-billed Sandpiper	*Limicola falcnellus*	Broome Port
Bar-tailed Godwit	*Limisa lapponica*	Broome Port (many)
Black-tailed Godwit	*Limosa limosa*	Broome Port (many)
Eastern Curlew	*Numenius madagascariensis*	Broome Port
Little Curlew	*Numenius minutes*	Broome Port (many)
Whimbrel	*Numenius phaeopus*	Broome Port (many)
Grey Plover	*Pluvialis squatarola*	Broome Port (many)
Painted Snipe	*Rostratula benghalensis*	Roebuck Plains
Common Greenshank	*Trigga nebularia*	Broome Port (many)
Terek Sandpiper	*Xenus cinereus*	Broome Port
Streaked Shearwater	*Calonectris leucomelas*	Cable Beach
Little Tern	*Sterna albifrons*	Broome Port (many)
Pin-tailed Snipe	*Gallinago stenura*	Broome
Swinhoe's Snipe	*Gallinago megala*	Broome
Common Redshank	*Triga tetanus*	Broome Bird Observatory
Marsh Sandpiper	*Tringa stagnatilis*	Broome Port (many)
Wood Sandpiper	*Tringa glareola*	Broome Port
Asian Dowitcher	*Limnodromus semipalmatus*	Broome Bird Observatory
Long-toed Stint	*Calidris subminuta*	Broome Port
Pectoral Sandpiper	*Calridis melanotos*	Broome Port
Sharp-tailed Sandpiper	*Calidris acuminate*	Broome Port
Ruff	*Philomachinus pugnax*	Broome Port
Common Tern	*Sterna hirundo*	Broome Port

Common Name	Species Name	Records
Brindled Tern	*Sterna anaethetus*	Broome Port
White-winged Black Tern	*Chlidonias leucopterus*	Broome Port (many)
Common Noddy	*Anous stolidus*	Broome Port
Wedge-tailed Shearwater	*Puffinus pacificus*	Yardoogarra, 50km south
Wilson's Storm Petrel	*Oceanites oceanicus*	Broome Port
Lesser Frigatebird	*Fregata ariel*	Broome Port (many)
Masked Boody	*Sulu dactylatra*	No local records
Brown Boody	*Sula leucogaster*	Broome Port (many)
Recorded in NatureMap		
Peregrine Falcon	*Falco peregrinus*	Recorded from project area
Fork-tailed Swift	*Apus pacificus*	Recorded from project area
Rainbow Bee-eater	*Merops ornatus*	Recorded from project area
Barn Swallow	*Hirundo rustica*	Recorded from project area

Source: Bamford (2010).

The area is also well known for the numbers of raptors, with 22 of the 24 Australian raptor species recorded around Broome.

3.3.2. Intertidal Communities and Shorebirds

Mangrove communities in the PMA are limited to minor patches along the main Roebuck Bay shoreline. Far more extensive mangrove stands occur in the local tidal creek systems such as Dampier Creek and Crab Creek. Mangroves contribute to primary productivity and the net export of organic matter, and support a diverse array of infauna (animals living or burrowing into the muddy sediments), epibenthic fauna (animals spending most time at the sediment surface), epifauna (animals living on the mangrove stems and roots) and, during high tide, temporary residents (sharks, rays and finfish). Mangroves also support a number of bird species that are specifically adapted and largely confined to this habitat. Typical residents in the Broome mangroves are the Mangrove Golden Whistler, White-breasted Whistler, Broad-billed Flycatcher, Dusky Gerygone and Yellow White-eye.

The sand beaches and upper intertidal flats are populated by infauna including ghost crabs, amphipods, polychaete worms and bivalve molluscs. The beaches are used by wading birds as feeding and nesting grounds and are potential nesting sites for marine turtles.

The rocky shores are colonised by barnacles, whelks, oysters, chitons and crabs. These provide feeding grounds for seabirds such as oyster catchers at low tide and fish at high tide. A number of rocky platforms and pavements at Entrance Point extend from the low intertidal into the subtidal zone (see next section). The tidal pools and sandstone platforms of Entrance Point support various sessile biota and mobile animals including octopi, cowries and other gastropod molluscs (marine snails). These platforms and pools provide foraging areas for several seabird species during low tides and for fish at high tide.

The Western Australian Minister for Environment has nominated the Roebuck Bay mudflats as a vulnerable threatened ecological community. The mudflats are described as the species-rich faunal community of the intertidal mudflats of Roebuck Bay. The bay is known to support a unique species-rich assemblage of marine creatures, particularly invertebrates (Burbidge 2004). Animals inhabiting the extensive lower intertidal sand and mud flats in Roebuck Bay include many types of worms, anemones, crustaceans and mollusc (both gastropod snails and bivalve clams) which help support the large seasonal and resident populations of wading birds.

Broome lies in an important region within the East Asian – Australasian corridor for migratory shorebirds. The major sites for resting and feeding migratory birds are the expansive tidal flats and mangrove areas fringing the eastern and southern shores of Roebuck Bay, plus Eighty Mile Beach further to the west. Both areas are designated Ramsar wetlands and would be very sensitive to the effects of oils spills. The largest number of waders counted at Roebuck Bay was 170,000 in October 1983 and the bay regularly supports over 100,000 birds, being the fourth most important wader site in Australia (CALM 2004). Large numbers of shorebirds arrive in the Broome region in September/October, remain for the summer then depart for Northern Hemisphere breeding grounds in April.

3.3.3. Subtidal Communities

The seafloor in the immediate vicinity of the jetty is well scoured by spring tide currents and does not support well developed seagrass beds. It does contain a small reef outcrop (presence and types of corals and other biota are unknown). Further away from the Port, there are patches of *Caulerpa* algae on the fine muddy sands of the tidal flats along Roebuck Bay, and their lowermost intertidal and shallow subtidal zones are colonised by *Halophila ovalis* and *Halodule uninervis* seagrasses. Seagrass beds of this type provide important forging areas for dugongs, which are common in the region (AHC 2003).

Subtidal rocky platforms and pavement are common around Entrance Point, providing habitat for shallow reef communities. These typically comprise seaweeds (40-50 species of macroalgae have been reported for Entrance Point) and a range of sessile invertebrate animals including sponges, anemones, hydroids, soft and hard corals, clams, oysters, and sea squirts and sea mosses (bryozoans). The reefal areas fringing Entrance Point experience relatively high water turbidities, and thus possess different and generally less developed hard corals than in clearer water areas further offshore.

The seafloor of the Inner Anchorage is dominated by soft sediments which are a mixture of wind-blown (aeolian) sands and clays and fine muds, which have originated from nearby shorelines and deposits from Dampier Creek during periods of flooding (the creek was formerly part of the Fitzroy River system). The shallow subtidal sediments are colonised by a range of benthic microalgae, burrowing animals and various soft coral and anemone species. The benthic microalgae contribute to primary productivity, biochemical cycling and sediment stability.

3.3.4. Marine Vertebrates and Shorebirds

The coastal rays, sharks and fishes of the Broome region are typical of those found in the Kimberley and Pilbara regions, and include schools of baitfish (sardines, anchovy and tropical herring) which are hunted by tuna, mackerel, sharks and seabirds. Seabirds commonly seen in Broome port include the Brown Booby, Frigate birds, the Darter, Osprey and Common Tern. No significant

seabird breeding colonies occur close to Broome, with the closest major breeding sites probably being some 120 km to the north on the Lacepede Islands.

Dugong (*Dugong dugon*) are known to occur in Roebuck Bay. The dugong is listed as a migratory species under the Bonn Convention and therefore under the EPBC Act. Under the EPBC Act dugongs are a listed marine species, although not listed as a 'threatened' species, meaning that it is an offence kill, injure, take, trade, keep, or move any dugong in Commonwealth waters without a permit. Further, the dugong has status as 'specially protected' under the *Wildlife Conservation Act 1950*. The dugong population in the Kimberley area is considered to be large and stable.

The two most common turtles in the Broome region are the green (*Chelonia mydas*) and flatback (*Natator depressus*) turtles. Both are listed as vulnerable and migratory under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act) and are listed as 'specially protected' under the W*ildlife Conservation Act 1950*. Female Green turtles come ashore from November to January to lay their eggs on beaches near Broome but not in the PMA. Flatbacks visit the northern coastal regions of Australia for feeding and breeding, extending as far south as the Tropic of Capricorn. This species prefers shallow, soft-bottomed seabed habitats away from reefs. Important nesting sites extend from the Kimberley region to the Torres Strait. Nesting frequency peaks between late November and early December, and ends by late January. Hatchlings emerge from nests from late December until about late March, with most hatchings in February.

Salt water crocodiles *(Crocodylus porosus)* are not common in Broome but can potentially occur in Port waters. They remain a protected species under Commonwealth and State Government Acts, with local DEC rangers responsible for following up on any sightings made at Broome.

A range of dolphin and whale species have been recorded in the Broome region, including the tropical Bryde's whales and humpback whales. Humpback whales (*Megaptera novaeangliae*) are regular winter migrants, since a significant portion of Australia's west coast population over-winters in the Kimberley region (the resting and calving area is north of Broome in the vicinity of Camden Sound). Most humpbacks migrate past Broome on their way to and from this area in June/July and October/November respectively, and they avoid Roebuck Bay as they generally prefer deeper waters offshore. Humpback whales are designated as a vulnerable and migratory species under the EPBC Act, and are also listed as 'specially protected' under the *Wildlife Conservation Act 1950*.

3.4. Socioeconomic Features

3.4.1. Heritage Values

Indigenous heritage and cultural issues within the PMA have been identified by Quartermaine Consultants (2000; archaeological) and O'Connor (2000; ethnographic). There are four sites of aboriginal archaeological significance registered with the WA Department of Indigenous Affairs. These are shell midden sites providing evidence of past aboriginal usage and presence in the coastal dunes.

There are two sites of aboriginal ethnographic significance within or near the PMA. These are a blackberry tree and rocks on a beach associated with dog dreaming. The recreation reserve northwest of the PMA also contains sites of significance to Aboriginal people associated with the Lurujarri Heritage Trail.

A Native Title claim (WC99_023) was lodged with the Native Title Tribunal in 1994 that included a large part of the PMA, the sub-tidal area and surrounding waters. The claim was lodged by Rubibi and the current status of Port lands is that they are not subject to Native Title.

Three buildings within the PMA adjacent Port Drive have been listed on the Shire of Broome's Municipal Directory for Heritage consideration. The buildings were originally part of the early quarantine station and are currently private residences. The houses are privately owned and are potentially relocatable if required.

No historic shipwrecks have been found in port waters and none are listed in the Register of the National Estate (RNE) or under the *Maritime Archaeology Act 1973* (Schedules 1 and 2) for nearby areas.

A *Flying Boat Wreckage Site* within Roebuck Bay has been permanently entered on the Register of Heritage Places, pursuant to Section 51 of the *Heritage of Western Australia Act.* The area covered by this registration covers the sites containing the remains of 15 flying boats that were destroyed in 1942 during a Japanese air attack. Six of the sites are located in the lower intertidal zone whilst the remaining nine are below the tide mark at the north end of the anchorage off Town Beach.

3.4.2. Port Economic Values

Broome is the principal trading port servicing the Kimberley region and has one of the highest vessel visit rates of all Western Australian regional ports. The Port plays a vital role in sustaining the region by providing import and export services, and is becoming increasingly important as a logistical port for the offshore oil and gas industry. Flow-on benefit to the local community includes both direct employment and income for local businesses that supply goods and services, plus regional economic activity from the export of livestock.

3.4.3. Commercial Fisheries

Commercial fishery operations in the Broome region comprise pearl culture operations, prawn and finfish trawling, and finfish trapping and wetlining. These activities provide an important contribution to the regional economy and rely on Broome Port services and infrastructure.

3.4.4. Tourism and Recreation

Broome is a popular tourist and recreational destination and provides a key link for marine tourism operators. As a cruise ship destination, the port provides a substantial source of income to local tour operators, hospitality services, pearl sales and gift retailers.

There are 36 charter boats registered at Broome (Economics Consultants 2003) and these have been increasing in number and size. Many operate locally with an emphasis on sport fishing, with the larger vessels moving further offshore for game fishing and scenic charter tours of the islands and mainland coast between Broome and Darwin.

A public accessible walkway along the southern side of the wharf linkbridge is used by the local community and visitors for angling and sight-seeing. There is no access to the wharf for non-authorised personnel in accordance with the *Maritime Transport and Offshore Facilities Act 2003* and regulations.

Entrance Point is popular for fishing, boating and swimming, and is the location of the sports fishing club and boat ramp. North of Entrance Point is a conservation/recreation reserve containing dunes that extend along the coast toward Riddell Point. The beaches further north are popular for beachgoers and swimming, although swimmers are exposed to the risk of Irukandji and box jellyfish stings, particularly during the summer months. The BrPA does not encourage public bathing within the PMA, and prohibits this activity near the jetty for safety reasons.

4. REGULATORY OBLIGATIONS

A key policy objective of BrPA is 'compliance with environmental legislation'. BrPA has obligations under various State and Commonwealth legislation, plus a duty of care under common law to protect the PMA environment from foreseeable risks.

BrPA is establishing a register of legal and other requirements containing all environmental permits, licenses, works approvals and Ministerial conditions relevant to its operations. Provisions for the review and audit of the Register of Legal and Other Requirements are made in the Legal and Other Requirements Procedure. This Procedure outlines processes to ensure BrPA takes account of legislative changes and amendments that occur from time to time so that BrPA can continue to achieve its compliance policy objective.

In accordance with the Legal and Other Requirements Procedure, summaries of relevant legislation are provided in Appendix A. International Agreements, Conventions and Memoranda of Understanding are not listed, except to the extent where their intent is reflected in Australian legislation. While care was taken to identify all relevant legislation, these tables should not be assumed to contain every possible statute. Users of this manual should refer directly to government copies of current laws, regulations and amendments if they require full details of the legislation summarised in Appendix A.

5. CURRENT ENVIRONMENTAL MANAGEMENT CONTROLS

Various guidelines and procedures have been developed by BrPA to manage the impacts of its operations on the environment. These procedures are detailed in a number of documents, primarily:

a) Environmental Management System (EMS);
b) Occupational Health and Safety Management System (OHSMS);
c) Marine Safety Plan (MSP);
d) Emergency Response Plan (ERP);
e) Cyclone Contingency Plan; and
f) Marine Oil Pollution Contingency Plan (MOPCP).

All persons working within the Port are required to be inducted and to comply with requirements of the OHSMS and the EMS.

5.1. BrPA Environmental Management Controls

5.1.1. Major Maintenance Work

Major jetty and navigation aid maintenance work is generally conducted by contractors. All contractors entering the site undergo a BrPA induction and operate under BrPA's Permit to Work System. A Contractors' Handbook provides guidelines and standards for all contractors on Port lands and infrastructure.

5.1.2. Navigation Aids

As described at articles 13 to 15 of the MSP, BrPA marker buoys are checked annually for position and fouling to ensure they are in the correct position and buoyant. Navigation lights are checked at least annually for correct illumination and colour.

5.1.3. Moorings

The Port requires mooring owners to have their moorings inspected annually by a qualified inspector. The location of moorings is required to be approved by the Port before they are installed. Mooring Standards are promulgated by the Port and require strict adherence by mooring owners.

5.1.4. Channels

Hydrographic surveys are commissioned annually by Department of Transport hydrographers. BrPA pilots monitor soundings within the channels during each pilotage movement to ensure there are no anomalies. If published depths have not been maintained then BrPA gives warning to vessels and the Australian Hydrographic Office is notified.

5.1.5. Berthing

Commercial vessels are not permitted to berth at the jetty without assistance and supervision by BrPA staff. BrPA Operations and pilots will oversee the berthing position for larger vessels and provides assistance to all visiting vessels. Procedures for safe berthing are detailed in articles 24 and 25 of the MSP and in the Port and Terminal Handbook.

5.1.6. Bunkering

BrPA has established fuel bunkering guidelines in Article 34 of the MSP covering all bunkering operations at the wharf. Bulk fuel transfers are the responsibility of the fuel suppliers and must be carried out within strict management regulations established by the suppliers in accordance with the BrPA Bunkering Permit System.

Management regulations/procedures include:

a) small vessel operators who use the bowsers (mostly fishing and pearling fleet) are to undergo a bowser induction by the relevant supplier and are to complete a BrPA bunker permit/safety checklist for each operation;
b) agents and operators wishing to use the high volume outlets are required to complete a BrPA bunker permit/safety checklist prior to each operation; and
c) transfers of bulk fuel from ship to shore must be carried out by supplier personnel to ensure compliance with the International Safety Guide for Oil Tankers and Terminals (ISGOTT), the Australian Institute of Petroleum (AIP) guidelines and Australian Standard AS 3846.

5.1.7. Cargo Handling

Procedures for loading and discharge of cargo have been established and are detailed at Article 37 of the MSP. All BrPA stevedores are trained to assist ship personnel with loading and unloading operations.

5.1.8. Dangerous Goods and Hazardous Cargo

General rules and procedures for dealing with dangerous goods handling and storage are detailed at articles 27 and 28 of the MSP. Dangerous goods are not stored on site but can be stored by appropriately accredited leaseholders.

More detailed procedures for handling of hazardous cargos, as defined under the *Dangerous Goods Safety (Goods in Ports) Regulations 2007*, are provided in BrPA's MSP. In accordance with this Regulation, BrPA requires all vessels carrying explosives, or intending to load explosives, to submit a *Permit to Handle Dangerous Goods other than Bulk Flammable Liquid or Bulk Liquid Gas* for approval 24 hours prior to entering the Port or prior to commencing cargo operations. Procedures for handling ammonium nitrate are contained at Article 28 of the MSP.

5.1.9. Oil Spill Management

There are three primary concerns for oil spill management within the PMA:

a) leaks or spills of minor volumes of oil, waste oil or oil based products stored and used onshore;
b) significant leaks or spills of oil during bulk transfer operations at the jetty; and
c) significant marine spills resulting from ship collision or grounding.

Oil Spills

In the event of an oil spill within the Port, the responsibility for initial and follow-up action lies with the BrPA. This is prescribed under various policies and legislation including:

a) the National Plan to Combat Pollution of the Sea by Oil (NATPLAN);
b) State Emergency Management Advisory Committee Policy Statement No. 7;

c) *Pollution of Waters by Oil and Noxious Substances Act 1987*;
d) *Environmental Protection Act 1986*; and
e) *Contaminated Sites Act 2003*.

BrPA addresses its responsibilities in its Oil Spill Contingency Plan (OSCP). The OSCP forms a comprehensive sub-plan of the Port's ERP and should be activated as the primary plan to combat pollution of the Port from oil. The ERP requires that all personnel who may be involved in the management of oil spills in the Port are conversant with the content of the National Plan (NATPLAN). Other responsibilities are contained at Westplan 2010.

BrPA's OSCP has been distributed to appropriate BrPA personnel, plus the fuel suppliers, major port users and safety and emergency service bodies.

5.1.10. Emergency Response Plan

BrPA's ERP outlines basic guidelines to be followed by BrPA personnel in the event of an incident occurring within the PMA. The ERP is designed to integrate with any other emergency management or counter disaster plan that is activated and impacts upon the responsibility of BrPA. The ERP also provides a detailed Cyclone Contingency Plan.

BrPA is the Lead Combat Agency responsible for managing all Port emergencies. However, many emergencies within Port boundaries are such that other authorities (such as FESA and WA Police) have the responsibility and/or provide key response capabilities.

5.1.11. Introduced Marine Pests

Ballast Water Management

The Port requires any ship wishing to discharge foreign sourced ballast water to comply with the Australian Ballast Water Management Requirements, which are enforceable under the *Quarantine Act 1908* (Cth). There must be evidence provided to the Department of Agriculture Inspector of its ballast water having been fully exchanged en-route between the overseas source port and Broome.

Ballast water management is not a major issue for many ships visiting Broome since the main port users (product tankers and general cargo ship) involve cargo unloading and usually have no need to discharge ballast water. This is also the case for visiting cruise liners, Naval units and fishing vessels. However, livestock carriers may require relatively small ballast water discharges (~500 tonnes), and these may be seawater, brackish water or fresh water, depending on vessel design and its immediate trade and previous port(s) of call.

Biofouling

Tropical marine fouling pests such as the black-stripe mussel (*Mytilopsis* sp.) and Asian green mussel (*Perna viridis*) have so far not managed to establish populations at Broome. Concerns over introduced marine pests are mitigated because:

a) vessel visits to Broome port are of short duration and do not involve temperature shocks or salinity falls associated with enclosed harbours and estuaries (factors which increase spawning responses by hull fouling biota);
b) the port's normal trade does not involve poor condition vessels arriving from overseas ports after lengthy periods of lay-up; and

c) suspected illegal entrant vessels (SIEVs) are no longer being held for long periods at either Broome Port or the nearby Willie Creek without adequate hull survey.

On the other hand, Broome Port does receive international cruising yachts and these are known vectors for a number of unwanted fouling pests, including the black-stripe and green mussels. There is also the potential for the introduction of non-native marine pests from domestic trading ships, workboats, fishing vessels or cruising yachts which were previously moored in north Queensland or Northern Territory ports, fishing harbours, inlets and marinas (i.e. places containing the Caribbean tube worm, *Hydroides sanctaecrucis* and/or Asian green mussels).

National Plan on Introduced Marine Pests

Under the National Plan for reducing introduced marine pest incursions, all ports are required to undertake biofouling 'housekeeping' actions, including regular cleaning of navigational aids, mooring buoys and jetty piles to reduce biofouling build-up, and to remove any abandoned hulks that can provide an ideal substrates allowing establishment of new fouling species. Marine pest monitoring by port survey and use of settlement plate devices is also being encouraged for all of Australia's regional as well major trading ports. The BrPA supports both the Department of Agriculture Seaports Program for ballast water management and the introduction of a National Plan that includes domestic vessel movements. Ports were advised in late 2007 of a national plan to undertake a baseline port survey of introduced marine species to facilitate the current national effort to improve ballast water and hull fouling management.

5.1.12. Bushfire Management

Procedures for the prevention and management of bushfire are in accordance with FESA local instructions.

5.1.13. Cultural Heritage Conservation and Protection

In 2000 BrPA commissioned studies to identify sites of aboriginal ethnographic significance (O'Connor 2000) and archaeological significance (Quartermaine 2000). The findings of these investigations were used to develop subsequent land use plans (ERM 2003; Whelans Town Planning 2013 in prep.) for the Port. BrPA undertook this exercise to ensure conservation and protection of heritage or culturally significant. Persons with an interest in heritage sites are consulted before any significant work that would impact on land managed by Broome Port is undertaken.

5.1.14. Grounds Maintenance and Weed Control

Formal procedures for general grounds maintenance, erosion control or the control of weeds onsite have not been formulated. These are undertaken on an as required basis.

5.2. Tenant Environmental Management Controls

To manage the potential environmental impacts associated with tenant activities, BrPA has developed a series of Tenant Environmental Management Requirements (TEMRs) as part of the BrPA EMS. TEMRs have been produced to cover general environmental management as well as management of more specific environmental factors, including:

a) flora;
b) fauna;

c) water;
d) land management;
e) heritage;
f) chemical handling;
g) emissions; and
h) waste management.

5.2.1. Contractors and Carriers

All contractors carrying out controlled works are required to operate under BrPA's Permit to Work System. A Contractors' Handbook provides guidelines and standards for all work conducted on Port lands and infrastructure.

5.2.2. Fuel Tank Farms

Reliance Petroleum operates under BP's licences, policies and procedures and is audited accordingly. BP is responsible for all environmental monitoring including groundwater testing from five bores and noise monitoring.

Site inductions, which include environmental content, are mandatory for all personnel working on the BP site. Site inductions are also given to any vessel operator using the jetty bowsers.

BP/Reliance Petroleum have a site specific ERP. The plan integrates with BrPA's ERP and OSCP, however BrPA has the Lead Combat Agency responsibility for response in the event of a spill.

The three Shell sites operate under Shell's Environment Protection Licences, Distributor Due Diligence System and EMP framework and are audited accordingly. Inductions are compulsory for any person working within their sites and for users of the jetty bowsers. Shell has developed ERPs for their installations and OSCPs for each site that integrate with BrPA's ERP and OSCP. Similarly, BrPA has the Lead Combat Agency responsibility for response in the event of a spill.

Shell is responsible for all environmental monitoring including groundwater monitoring bores situated in all three operational areas.

5.2.3. Aquaculture Park

An overarching EMP for management of the aquaculture park has not been developed by Fisheries, nor were site specific EMPs developed by the individual tenants during the development approval stage, as is now required across the port site. However, all tenants are required to meet the conditions of their lease and the conditions specified in their aquaculture licences issued by Fisheries under the *Fish Resources Management Act 1994* ('FRMA') and in the case of pearling licences, the *Pearling Act 1990*. There are other provisions of the FRMA and Pearling Act that also apply to their operations. These provisions are not necessarily contained in the sub-leases/ licences. The *Enzootic Diseases Regulations 1970* also applies and tenants involved in the aquaculture of prawns are required to have disease outbreak plans in place. Paspaley Pearls in particular has a comprehensive Disease Contingency Plan and Hatchery Operations Manual that incorporates the requirements of their pearling licence, the Pearl Oyster Fishery Ministerial Policy Guidelines and the Pearling Industry Translocation Protocol.

5.2.4. Broome Stockyards

The former stockyards on Lot 514 were previously classified as prescribed premises under the *Environmental Protection Act 1986.* This licence was rescinded at the closure of the stockyards.

5.2.5. Toll Mermaid Offshore Supply Base

The Toll Mermaid Logistics Broome Pty Ltd offshore supply bases are ISO 9001 certified and store all hazardous materials according to the *Dangerous Goods Safety Act 2004* and associated regulations. The sites operate under an internal EMP and OSCP that covers all operations within the fence line. The Toll Mermaid operations do not incorporate activities at the jetty. Toll Mermaid Logistics Broome Pty Ltd is audited both internally and independently under the ISO 9001 quality scheme.

6. ENVIRONMENTAL RISK REGISTER

Port operations and activities, by their nature, have the potential to impact upon one or more aspects of the natural or social environment. BrPA's operations, and aspects of tenant operations that have the potential to impact upon the environment of the PMA, have been evaluated in an environmental risk register. The risk register describes activities undertaken within the PMA, identifies the likely environmental and social issues and summarises operational controls currently in place to mitigate these impacts. The function of the risk register is to facilitate the development of operational controls relevant to specific activities.

6.1. Definitions

Definitions for terms used in the Aspects and Impacts Procedure and the Aspects and Impacts Register (as adapted from ISO 14001:2004) are provided below.

Environment is the surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation.

Environmental Aspect is an element of an organisation's activities, products or services that can interact with the environment.

Environmental Impact is the change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects.

Environmental Risk is a risk that arises from the relationship between human activities and the environment.

Environmental risks include:

- A risk to the environment.
- A risk to BrPA from environment-related issues, including the risk of non-compliance with legislative and other criteria

Significant Environmental Aspect is an environmental aspect that has or can have a significant environmental impact.

Environmental Objective is an environmental goal, consistent with the environmental policy, that an organisation sets itself to achieve.

Environmental Target is a detailed performance requirement applicable to the organisation or parts thereof, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives. Environmental targets are aligned with significant environmental aspects and should be quantifiable where practicable.

Environmental Performance is a measurable result of the environmental management system, related to an organisation's control of its environmental aspects. Results can be measured against its environmental policy, environmental objectives and environmental targets.

Procedure is a specified way to carry out an activity or process.

Risk is an effect of uncertainty on objectives (as defined in ISO 31000:2009).

Record is a document stating results achieved or providing evidence of activities performed.

a) environmental issue – how activity interacts with the environment (e.g. inputs and outputs from a process);
b) environmental impact – the actual or potential impact on the environment;
c) inherent risk – the risk that is present prior to the application of any controls; this demonstrates to readers that the controls are reducing environmental impact and the potential risks should the controls fail;
d) likelihood – the probability of consequences occurring;
e) consequence – described in terms of environmental impact (severity, duration and extent) as well as in terms of business consequences (e.g. fine);
f) controls – a description of the policies and/or procedures that are currently in place (but not future controls); and
g) residual risk – the level of risk still present after controls have been applied.

6.2. Methodology

The method used for prioritising environmental impacts is based on the concept that the significance of the environmental issue is a combination of the negative consequence and the likelihood of that negative consequence occurring: Hence the relationship: Risk = Consequence x Likelihood. This methodology has been adopted to ensure that the risk assessment process is repeatable, though it does not represent an exhaustive, quantitative risk assessment. Assessment of risk is consistent with AS/NZS 4360 (1999).

Key environmental issues have been analysed and ranked to provide a mechanism for identifying and managing high priority environmental issues before attention is given to issues of a lower priority. Current policies and procedures for environmental management are taken into account when assessing likelihood and consequence of possible adverse outcome.

Evaluation of the significance of an environmental issue can be facilitated by consideration of a number of factors (AS/NZS ISO 14004:1996):

a) duration of impact;
b) long-term sustainability;
c) probability of occurrence;
d) cost of changing the impact;
e) scale and severity of impact;
f) concerns of interested parties;
g) potential regulatory and legal exposure;
h) difficulty of changing or removing the impact;
i) effects on the public perception of the Authority; and
j) effect of change on other activities and processes.

A semi-quantitative measure of the likelihood of the adverse environmental outcome occurring, at the level of consequence assigned is described in Table 3.

Table 3 Likelihood of Adverse Environmental Outcomes Occurring

Level	Descriptor	Description	Frequency
1	Rare	The event may occur only in exceptional circumstances.	Less than once in 15 years <20%
2	Unlikely	The event could occur at some time.	At least once in 10 years 20% to 40%
3	Moderate	The event will possibly occur at some time.	At least once in 5 years 40% to 60%
4	Likely	The event will probably occur in most circumstances.	At least once in 1 year 60% to 80%
5	Almost certain	The event is expected to occur in most circumstances.	More than once per year >80%

Adapted from AS/NZS ISO 31000:2009.

The measures of consequence for possible environmental outcomes are described in Table 4. It should be noted that the descriptions are not 'all inclusive' and judgement has been required in assessing issues.

Table 4 Measures of Consequence for Possible Environmental Outcomes

Consequence		Environment and Heritage Impacts
1	Insignificant	No impact upon environment. Rate of persistence/permanency of impact < 1 day. Clean-up cost <$1,000. Limited impact to areas of low heritage significance.
2	Minor	Rate of persistence / permanency of impact 1 day to 1 month. Clean-up cost $1,000 to $5,000. Standard regulatory reporting with no breach. Short term, minor impact on areas of low heritage significance. Standard regulatory reporting with no breach.
3	Moderate	Regulatory involvement and/or reporting a breach. Rate of persistence/permanency of impact 1 month to 2 years. Clean-up cost $5,000 to $50,000. Minor to medium term impacts on areas of heritage significance. Regulatory involvement and/or reporting a breach.
4	Major	Regulatory fine and/or warning. Rate of persistence/permanency of impact 2 to 10 years. Clean-up cost $50,000 to $100,000. Medium to long term impacts on areas of heritage significance. Regulatory fine and/or warning.
5	Catastrophic	Loss of licence and/or prosecution. Rate of persistence/permanency of impact more than 10 years. Clean-up cost more than $100,000.

		Long term or permanent damage to areas of heritage significance. Potential prosecution.

Note that Table 4 is an extract of BrPA's full consequence matrix, which contains other factors (e.g. health and safety, financial, legal) BrPA considers in its risk assessment processes.

The consequence/likelihood matrix for determining the priority of issues is shown in Table 5. The likelihood and consequence allocations of issues are multiplied to determine overall risk ranking and to provide a basis for management priority. Calculated risk rankings range from the highest (a value of 25) to the lowest (a value of 1). Different levels of risk require different management responses as detailed in Table 6.

Table 5 Qualitative Risk Analysis Matrix

Consequence	Likelihood				
	Rare 1	**Unlikely 2**	**Moderate 3**	**Likely 4**	**Almost Certain 5**
Insignificant 1	1	2	3	4	5
Minor 2	2	4	6	8	10
Moderate 3	3	6	9	12	15
Major 4	4	8	12	16	20
Catastrophic 5	5	10	15	20	25

Table 6 Risk management response levels

Risk Score	Descriptor	Management Response
1 to 3	Acceptable	Acceptable with adequate controls. Management is responsible.
4 or 5	Monitor	Acceptable with adequate controls. Management is responsible.
6 to 9	Management control required	Acceptable with adequate controls. Management is responsible.
10 to 14	Urgent management action required	Acceptable only with excellent controls. Responsibility of CEO.
15 to 25	Unacceptable	Acceptable only with excellent controls. Responsibility of Board.

6.3. Register

The aspects and impacts register from BrPA's EMS is provided as the environmental risk register.

Table 7 Environmental Risk Assessment

Aspect	Potential Impacts	Controls (Existing)	Risk Score		
			C	L	R
Wharf and Port Waters					
Unloading and loading of cargo	• Spill affecting the marine environment • Dust emissions	High risk work licences Training SOPs and JHAs MSDS	2	2	4
Vessel to vessel transfers	• Spill affecting the marine environment • Dust emissions	Port Handbook Permit to work system	2	2	4
Onboard transfers	• Spill affecting the marine environment • Dust emissions	Port Handbook	2	2	4
Livestock loading and fodder storage	• Animal/fodder waste entering marine environment impacting water quality and increased nutrient levels	Training SOP and JHA including jetty cleaning procedures Scheduling minimal storage time on wharf	2	4	8
Bulk transfer & bunkering - port user undertaking activities e.g. bunkering, bulk transfer	• Spill/leak affecting the marine environment impacting mud flats and marine fauna • Stakeholder impact	Permit to work Port Induction Copies of certificates and calibration Fuelling induction Firewatch for tanker Spill kits	4	3	12
Vessels alongside	• Hydrocarbon release into the marine environment • Air emissions resulting in pollutants entering the atmosphere • Invasive marine pest species entering marine environment from vessel • Noise emissions from vessels	No ballast water discharge in Port Waters	5	2	10
Operation of vessels in port limits	• Collision/allision resulting in oil spills and impacts to marine fauna and environment	Availability of Port Handbook Adherence to radio communication protocols Spill response coordination	4	1	4

Aspect	Potential Impacts	Controls (Existing)	Risk Score		
			C	L	R
Spill response coordination	• Spill not contained effectively or in a timely manner and resulting additional impacts to environment • Regulatory breaches from inadequate reporting of the spill.	Spill Response Procedure Emergency Response Plan Marine Oil Pollution Contingency Plan Supplies of spill response booms/equipment Regular drills Personnel trained in spill response with DoT	5	2	10
Small vessel washdown at wharf	• Spill/leak affecting the marine environment impacting mud flats and marine fauna • soil contamination, groundwater contamination and chemicals entering the Bay • Use of finite resources (water)	Permission sought from Master for cruise vessels to wash down	1	5	5
Ship overboard discharges	• Spill/leak affecting the marine environment impacting mud flats and marine fauna • Incorrect waste disposal		3	2	6
Provision of public walkway	• Waste pollution into marine environment impacting marine fauna and birds	Provision of bins on walkway Regular emptying of bins	2	3	6
Truck and vehicle movement	• Air emissions resulting in pollutants entering the atmosphere • Spill/leak affecting the marine environment impacting mud flats and marine fauna	Spill kits	1	3	3
Light emissions from jetty	• Light impacting marine species		2	2	4
Cleaning of the jetty	• Waste and residues entering marine environment impacting water quality, increased nutrient levels and marine fauna	Procedures to clean jetty for livestock vessels	2	4	8
Fuel, paint and chemical storage on jetty	• Waste and residues entering marine environment impacting water quality, increased nutrient levels and marine fauna • Spill/leak affecting the marine environment impacting mud flats and marine fauna		3	2	6

Aspect	Potential Impacts	Controls (Existing)	Risk Score		
			C	L	R
Maintenance work on jetty	• Incorrect waste disposal • Waste and residues entering marine environment impacting water quality, increased nutrient levels and marine fauna • Spill/leak affecting the marine environment impacting mud flats and marine fauna • Escape of asbestos if present and not managed properly	Permit to work Induction JHA	3	3	9
Maintenance work by contractors on jetty	• Waste and residues entering marine environment impacting water quality, increased nutrient levels and marine fauna • Spill/leak affecting the marine environment impacting mud flats and marine fauna • Escape of asbestos if present and not managed properly	Permit to work Induction JHA Contractor work pack	3	3	9
Provision of staff facilities	• Consumption of natural resources including energy, water and paper	Goal to reduce water and energy consumption in HSE Activity Plan	1	4	4
Consumption of water and energy	• Use of a finite resource	Goal to reduce water and energy consumption in HSE Activity Plan	1	4	4
Operation of machinery	• Spill/leak affecting the marine environment • Use of resources (fuel, water) • Noise emissions	Spill kits Maintenance in MEX	1	3	3
Waste disposal and storage	• Waste pollution entering marine environment from skip/bin impacting marine fauna, birds and potentially mud flats • Spill/leak affecting the marine environment impacting mud flats and marine fauna • Regulatory breaches for incorrect disposal of controlled wastes	Skips with lids Regular bin emptying Spill Kits Waste oil shed with bund	3	3	9
Abrasive blast and paint	• Air emissions resulting in pollutants entering the atmosphere • Spill/leak affecting the marine environment impacting mud flats and marine fauna • Breach of operating licence if not carried out correctly • Impacts to marine organisms from organotin paints	Hessian shade cloth over platforms Manual sweep up Organotin paints not to be used on objects in water.	4	3	12

Aspect	Potential Impacts	Controls (Existing)	Risk Score		
			C	L	R
Port controlled and contracted vessels operating in port limits	• Spill/leak affecting the marine environment impacting mud flats and marine fauna • Incorrect disposal of waste include oily engine waste entering the marine environment impacting mud flats and marine fauna		2	2	4
Allocation and administration of moorings	• Spill/leak affecting the marine environment impacting mud flats and marine fauna • Incorrect disposal of waste include oily engine waste entering the marine environment impacting mud flats and marine fauna • Introduction of Invasive pest species	Annual Inspections of moorings required Permit and allocation process	2	2	4
Project work	• Environmental damage due to failure to adequately assess environmental risks.	Risk Assessment procedure Review of project works' environmental aspects/impacts to involve HSE Officer	4	2	8
Exterior lighting	• Disturbance to marine fauna and migratory birds • Use of resources	Nesting platform provided above wharf floodlights Only lighting necessary for operations and security kept on at night Lights extinguished in daylight hours unless required for safety purposes	2	2	4
Procurement of goods	• Goods require resource-intensive manufacturing processes/materials • Goods require intensive use of resources during operation • Goods produce high levels of emissions during operations • Goods have a detrimental environmental impact when disposed of at end of life		1	3	3
Provision and maintenance of navigational aids	• Collision/allusion resulting in oil spills and impacts to marine fauna and environment • Impact to marine organisms from organotin paints	Maintain navigation aid visibility (visual and/or radio as appropriate). Ensure navigation aid position is as reported on marine charts. Organotin paints not to be used on objects in water.	4	1	4

Aspect	Potential Impacts	Controls (Existing)	Risk Score		
			C	L	R
Hydrographic surveys	• Collision/allision resulting in oil spills and impacts to marine fauna and environment • Inaccurate survey results obtained, leading to collision/allusion.	Use reputable hydrographic surveyor. Contractor management procedures. Define operational parameters for hydrographic survey, including communication protocols between surveyor/BrPA /others prior to commencement of survey.	4	2	8
BrPA Controlled Lands					
Chemical, fuel and paint storage	Spill/leak resulting in soil contamination, groundwater contamination and chemicals entering the Bay through stormwater	Bunding Designated cabinets	2	1	2
Engagement of contractors for works	Spill/leak resulting in soil contamination, groundwater contamination and chemicals entering the Bay Incorrect disposal of waste Clearing of vegetation Damage to heritage listed areas Incorrect disposal of waste	Tender Permit to work system JHAs	4	2	8
Maintenance work on Port Lands	Spill/leak resulting in soil contamination, groundwater contamination and chemicals entering the Bay Incorrect disposal of waste	Permit to work system JHAs Spill Kits	2	2	4
Maintenance of equipment	Spill/leak resulting in contaminated soils, entering the marine environment impacting mud flats and marine fauna	Regular maintenance entered into MEX	2	2	4
Use of chemicals, fuels and paints	Pesticide/herbicide application on gardens Fuel spills	Spill Kits	2	2	4
Waste oil storage	Spill/leak resulting in soil contamination, groundwater contamination and chemicals entering the Bay through stormwater	Designated area (not bunded)	3	3	9
Stormwater management	Uncontrolled runoff from developed/cleared areas leading to increased sediment loading in bay or contaminants entering the bay		2	5	10
Vehicle wash down	Spill/leak or fuel residues running off and resulting in soil contamination, groundwater contamination and chemicals entering the Bay		3	3	9

Aspect	Potential Impacts	Controls (Existing)	Risk Score		
			C	L	R
Blast and paint on port lands	• Air emissions resulting in pollutants entering the atmosphere • Spill/leak affecting the marine environment impacting mud flats and marine fauna • Soil contamination, groundwater contamination and chemicals entering the Bay	Cyclone fences with mesh/hessian Regular clean up of garnet and any abrasive material Work conducted on concrete	3	3	9
Management and use of slipway	• Air emissions resulting in pollutants entering the atmosphere • Spill/leak affecting the marine environment impacting mud flats and marine fauna • Soil contamination, groundwater contamination and chemicals entering the Bay • Incorrect waste disposal • Stakeholder impact	Permit to Work Lock & key system	4	3	12
Public use of entrance point boat ramp and car park	• Spill/leak affecting the marine environment impacting mud flats and marine fauna • Incorrect disposal of waste entering the marine environment impacting marine fauna	Signage Bins	2	2	4
Public traffic access and traffic control Cleaning of roads and/or dust control	• Oils from vehicle use entering marine environment via stormwater runoff • Increased dust and particulate matter in air	Removal of excess sand/soil on roads by contractor on an as-required basis	1	4	4
Remediation of contaminated sites	• Legacy of contaminated soils left • Contamination of groundwater • Legal liability	Tenant inspections BrPA to regularly follow up with fuel depot tenants about contaminated lands and remediation progress	4	2	8
Land use planning	• Siting of developments in inappropriate locations with respect to conservation areas	Approvals obtained early in planning process Liaison with Shire, indigenous heritage groups	3	2	6
Stakeholder engagement	• Stakeholders remain informed about and feel engaged with current issues [+] • Undue stakeholder influence causes BrPA strategic goals to be not met, e.g. popular perceptions leading to less than ideal outcomes (whether for BrPA or the environment)	Regular meetings with port logistics group BrPA member of Roebuck Bay working group Liaison with other stakeholders as required	2	3	6
Offices					
Waste disposal and storage	Waste generation – use of resources		1	4	4

Aspect	Potential Impacts	Controls (Existing)	Risk Score		
			C	L	R
Operation of electrical devices	Use of resources		1	4	4
Consumption of resources such as water, electricity and paper	Use of resources		1	4	4
Vehicle use	Use of resources Emissions to air		1	4	4
Travel for employees and contractors for meetings, training, audits, maintenance etc	Carbon emissions		2	3	6
Tenants and Development					
Land clearing and development	• Loss of environmental values from removal of native vegetation • Unauthorised clearing resulting in loss of significant plant species • Stakeholder impact • Impact to indigenous heritage site	Tenant Environmental Management requirements (TEMRs) Audits	4	3	12
Alteration of surface water flows	• Removal of soil • Increased flow resulting in increased sedimentation running into Bay during weather events	TEMRs BrPA constructing sedimentation basin Stormwater management plan Audits	3	3	9
Noise emissions	• Noise impacting terrestrial species	TEMRs Audits	2	2	4
Light emissions	• Light impacting terrestrial species	TEMRs Audits	2	2	4
Consumption of water , paper and electricity	• Use of resources		1	4	4
Waste disposal and storage	• Waste pollution entering environment from skip/bin impacting fauna and birds • Spill/leak affecting the marine environment impacting mud flats and marine fauna, • Spill/leak resulting in soil contamination and/or affecting groundwater	TEMRs Audits	3	2	6

Aspect	Potential Impacts	Controls (Existing)	Risk Score		
			C	L	R
Chemical, fuel and paint storage	• Spill/leak resulting in soil contamination, groundwater contamination and chemicals entering the Bay through stormwater	TEMRs Audits	5	2	10
Vehicle wash down	• Spill/leak or fuel residues running off and resulting in soil contamination, groundwater contamination and chemicals entering the Bay		3	3	9

Notes: L = likelihood, C = consequence and R = risk.

7. IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT PLAN

Practices and controls for managing the risks identified in section 5 are currently presented as 'guidance card' style procedures (see Appendix B). These procedures are focused on management of BrPA operational activities that may have an impact upon environmental quality rather than the environmental aspects the Port needs to protect. The guidance cards incorporate information relevant to the protection of the environment and are focused on practical impact avoidance and risk mitigation. Separate cards have been developed for each BrPA activity or group of similar activities.

BrPA's options for management of contractor and tenant activities are discussed separately in section 7.3.

7.1. Guidance Card

The guidance cards have been developed to provide a useful and easily understood tool for use by managers and port staff and are styled to be used as the basis for personnel training. The guidance cards developed for BrPA contain the following information:

a) activity – activity pertaining to card;
b) objective – environmental objective pertaining to each activity;
c) relevant activities – a more specific list of activities that could potentially harm the environment;
d) environmental management procedures – practices that may be used in concert with existing controls, to reduce the impact of current operations;
e) likely pollutants – type of pollutants that should be targeted for pollution prevention and control;
f) environmental at risk media – the environmental features (air, water, land, groundwater, social or heritage) that are likely to be affected by the activity; and
g) considerations – this section includes discussions on effectiveness, cost and the need for staff/ tenant training.

The guidance cards cover most port operations, including:

a) fuelling operations (bunkering) at the jetty;
b) general cargo handling (other than dust generating activities, hazardous waste and livestock);
c) cargo handling – dust generating materials;
d) ship- and shore-generated solid waste handling;
e) ship air emissions;
f) vessel repair and maintenance;
g) maintenance of the jetty and navigation aids;
h) waste oil management;
i) chemical storage and handling;
j) miscellaneous storage;

k) building and grounds maintenance;
l) vehicle and equipment maintenance;
m) stormwater, erosion and dust control;
n) protection of marine mammals and sensitive aquatic habitats;
o) public access and recreation;
p) land clearing;
q) management of environmentally and culturally sensitive areas; and
r) livestock handling.

The following port operations are not covered by guidance cards:

a) catastrophic fuel spill, as this is covered by the OSCP;
b) emergency response, as this is covered in the ERP; and
c) discharge of bilge and ballast water from ships, as these are covered by MARPOL 73/78 and Department of Agriculture regulations.

Information from the guidance cards will be progressively transitioned into BrPA Safe/Standard Operational Procedures as the EMS is implemented further.

7.2. Implementation

The key to successfully reducing environmental impact from daily port operations is proper implementation of environmental management procedures. To ensure effective implementation, BrPA will:

a) communicate the EMP to staff and train personnel responsible for implementation. Failure to involve all staff means that some may have little understanding of the issues and no ownership of the management measures that should be implemented;
b) make environmental considerations an integral part of the port's decision making process (including development and expansion);
c) include environmental policies in leases and contracts;
d) include all or elements of the guidance cards in work orders when using external contractors; and
e) periodically review port operations where these procedures are implemented.

7.3. Managing Contractors and Tenants

BrPA has the real or perceived responsibility to ensure operations of tenants are conducted according to legislation and regulations. This is compounded by the increasing interest from local communities in protecting the natural and social environment, and BrPA is faced with greater challenges to reduce the real or perceived effects of tenant operations.

As separate business entities, tenants have the primary individual responsibility to ensure that their activities meet environmental regulatory requirements. Allocation of environmental risk is important as BrPA may have to carry the cost of remediation and environmental contamination caused by tenant activities. However, some tenants may not fully understand or not be capable of meeting their

environmental obligations. BrPA is in a position to assist these tenants in understanding these obligations and better manage environmental risks. Mechanisms available to BrPA to define the environmental responsibilities of tenants include:

a) leases – a legally binding contract to define the terms of the relationship;
b) Port rules and procedures – requirements and guidelines developed by BrPA or jointly with the tenant to incorporate into leases, i.e. the tenant environmental management requirements;
c) environmental legislation – use of legislation to define responsibility; and
d) economic factors – in order to retain tenants and attract new tenants, BrPA may choose to assume additional environmental responsibilities.

The Broome Port Authority Port Logistics Consultative Working Group is convened on a quarterly basis for meetings to discuss current and planned activities at the port. The group consists of BrPA staff, BrPA tenants, contractors, commercial users, government regulators and other persons or organisations with an interest in the port. The meetings provide a forum for BrPA to provide updates on port operations and planning, as well as for other attendees to raise issues for discussion or share information related to their own business at the port with others.

7.4. Environmental Monitoring and Review

One of the central aspects of EMP implementation is monitoring the effectiveness of the procedures in reducing environmental impacts. A monitoring programme should be developed so that procedures may be improved or new ones developed. Monitoring may involve collection of environmental data such as water and sediment quality, and visual characteristics such as reduced erosion.

This EMP should be reviewed at a minimum of every five years, or at more frequent intervals should significant changes occur in port activities or the regulatory environment. The EMP was last reviewed in 2010.

It is noted that BrPA's EMS – intended to be operational prior to the subsumption of BrPA into the Kimberley Ports Authority on 1 July 2014 – will provide much of the structure required to ensure that the management measures in this EMP are effected. Certain requirements of the EMS under AS/NZS ISO 14001:2004 relate to ensuring monitoring is carried out and, where necessary, corrective actions are taken. AS/NZS ISO 14001:2004 also requires audit and review procedures to be stipulated to ensure that the effectiveness of the EMS and its constituent parts is continued.

A gap analysis was conducted in late 2011 to guide the development of the EMS. An environmental audit of BrPA's tenants' sites was also conducted in 2012. The results from these audits and other site inspections will be used for comparison during the first initial internal audits and reviews once the EMS is operational.

This version of the EMP has been updated to reflect changes in the regulatory environment and changes resulting from the introduction of BrPA's EMS. It is expected that this EMP will be revised periodically to ensure it remains consistent with the EMS.

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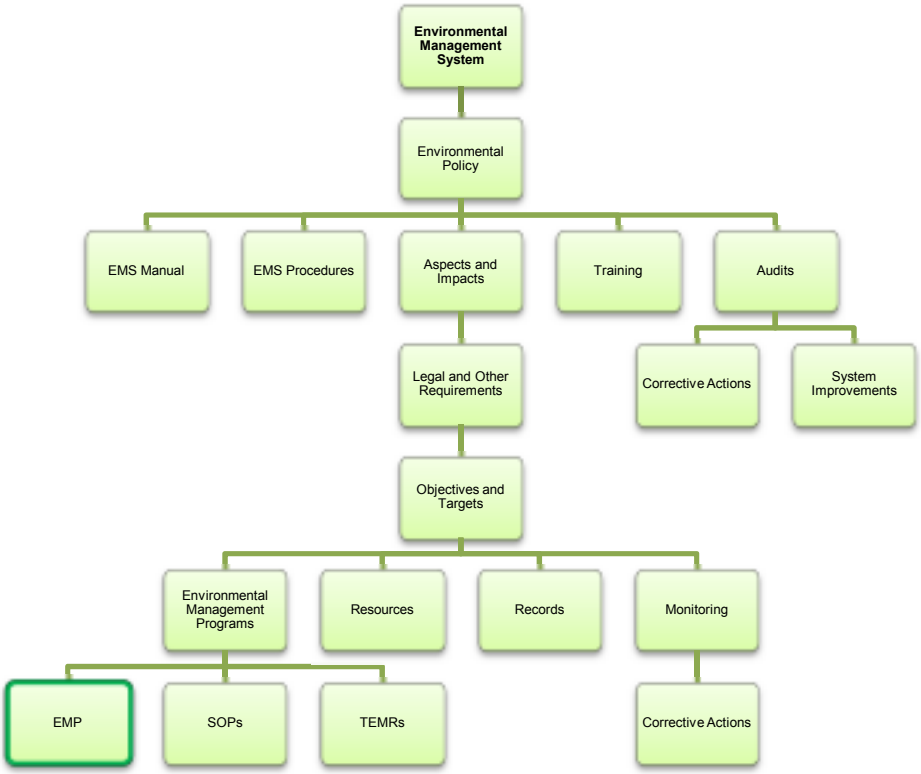
9. DOCUMENT INFORMATION

This document's context in the EMS is shown below.

EMS Classification	
Process Map	
Document Map	Environmental Management System **Environmental Management Plan**

APPENDIX A: REGISTER OF LEGAL OBLIGATIONS

Legal or Other Requirement	Source and Jurisdiction	Evidence Required for Compliance	Evaluation of Compliance
The Act confers a responsibility upon BrPA to protect the environment of the port and minimise the impact of port activities.	*Port Authorities Act 1999* (WA)	Implementation of environmental management, e.g. the EMS.	
Develop an EMP for the port.	*Port Authorities Act 1999* (WA)	An EMP.	
Submit an annual report to the Minister that includes a summary of BrPA performance in relation to protecting the environment of the port and minimising the impact of port activities on that environment.	*Port Authorities Act 1999* (WA)	Annual report with required environmental content.	
Refer proposals to the EPA that appear likely to, if implemented, have a significant impact upon the environment.	*Environmental Protection Act 1986* (WA)	Referrals to the EPA or documentation supporting decisions not to refer, e.g. risk assessments, memos or emails (where applicable). No unassessed projects with significant impacts.	
Obtain clearing permits prior to disturbing vegetation (includes both terrestrial and marine plants).	*Environmental Protection Act 1986* (WA)	Clearing permits or discussions with DER about the need for clearing permits (where applicable). No unauthorised clearing.	
BrPA activities must not directly result in significant emission or discharges. A works approval must be obtained to construct or alter any facility (a prescribed premise) that will emit or discharge, and a licence or registration obtained to operate such a facility.	*Environmental Protection Act 1986* (WA)	Works approvals, licences, registrations or discussions with DER about the need for any of these (where applicable). No unauthorised discharges.	
The application of organotin anti-fouling paint to any piling, pier, buoy, mooring or other structure in an enclosed or semi-enclosed water body is prohibited.	Environmental Protection Regulations 1987 (WA)	Ask Maintenance Supervisor about anti-fouling paints used.	
BrPA must not clear vegetation without a valid clearing permit unless the clearing is exempted. Note: exemptions currently not possible as Broome is currently declared an Environmentally Sensitive Area (ESA) within which the usual exemptions do not apply.	Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA)	Clearing permits or discussions with DER about the need for clearing permits (where applicable). No unauthorised clearing.	

Legal or Other Requirement	Source and Jurisdiction	Evidence Required for Compliance	Evaluation of Compliance
Discharge of any of the following is prohibited: • acid with a pH less than 4; • alkali with a pH more than 10; • animal waste; • oil, fat or grease; • compounds or solutions of cyanide, chromium, cadmium, lead, arsenic, mercury, nickel, zinc or copper; • degreaser; • detergent, engine coolant or engine corrosion inhibitor; • food waste; • laundry waste; • mineral oil; • organic solvent; • paint; • petrol, diesel or other hydrocarbon; • sediment or sewage.	Environmental Protection (Unauthorised Discharges) Regulations 2004 (WA)	Inspect possible discharge points (e.g. outside drainage) for evidence of unauthorised discharges. No unauthorised discharges reported (STEMS). No complaints about unauthorised discharges from external parties.	
BrPA has responsibility to respond to oil or oily water spills within the port limits.	*Pollution of Waters by Oil and Noxious Substances Act 1987* (WA)	Incident reports (STEMS). No oil/oily water incidents unreported.	
Note: No marine protected areas are currently declared within the port limits. However, in October 2010 the premier announced the formation of the Kimberley Wilderness Park, including the Roebuck Bay Marine Park. As a key stakeholder, BrPA will need to consult with the DPaW prior to the declaration of the marine park and completion of the marine park management plan. Further, BrPA will need to ensure that its activities are consistent with the future marine park.	*Conservation and Land Management Act 1984* (WA)	(Not applicable.)	
Not to take protected flora or fauna without first obtaining an appropriate licence. Not to take declared rare flora without first obtaining written approval from the Minister for the Environment.	*Wildlife Conservation Act 1950* (WA)	Permit To Take (where applicable). No flora or fauna taken without appropriate licence or by unauthorised person.	
Not to in any way alter, remove, destroy, damage, or assume the possession, custody or control of any maritime archaeological site, ship or relic.	*Maritime Archaeology Act 1973* (WA)	Correspondence, plans, permits etc. for any work involving disturbance to marine areas where shipwrecks might be found. Incident reports (STEMS).	

Legal or Other Requirement	Source and Jurisdiction	Evidence Required for Compliance	Evaluation of Compliance
Not to excavate, destroy, damage, conceal, alter, assume possession of, or deal with in a manner not sanctioned, any Aboriginal site or object.	*Aboriginal Heritage Act 1972* (WA)	Incident reports (STEMS). Any suspected sites cordoned off and further advice sought.	
(No requirements identified.)	*Native Title Act 1994* (Cth)	(Not applicable.)	
Ensure all reasonably practicable measures are taken to store, handle or transport dangerous goods so that risks to people, property and the environment are minimised.	*Dangerous Goods Safety Act 2004* (WA)		
Develop a Safety Management System to ensure compliance with AS3846-1998.	Dangerous Goods Safety (Goods in Ports) Regulations 2007 (WA)	Safety Management System.	
Submit to the Department of Mines and Petroleum an Emergency Plan.	Dangerous Goods Safety (Goods in Ports) Regulations 2007 (WA)	Emergency Response Plan.	
Obtain all necessary approvals such as Special Berth or Restricted Area approval.	Dangerous Goods Safety (Goods in Ports) Regulations 2007 (WA)	Special Berth licences or Restricted Area approvals.	
Restricted Areas must be adequately bunded.	Dangerous Goods Safety (Goods in Ports) Regulations 2007 (WA)	Bunds around Restricted Areas when in operation (if applicable).	
A Dangerous Goods Declaration is to be submitted to the Harbourmaster for approval for all vessels carrying or intending to load hazardous cargoes.	Dangerous Goods Safety (Goods in Ports) Regulations 2007 (WA)	Dangerous Goods declarations.	
Any releases of hazardous cargoes must be reported.	Dangerous Goods Safety (Goods in Ports) Regulations 2007 (WA)	Incident reports (STEMS). Incident reports to agencies (as required).	
Store dangerous goods according to the procedures prescribed in the regulation.	Dangerous Goods Safety (Storage and Handling of Non-Explosives) Regulations 2007 (WA)	Storage of dangerous goods according to the regulations (if applicable).	

Legal or Other Requirement	Source and Jurisdiction	Evidence Required for Compliance	Evaluation of Compliance
Report incidents in following situations: 1. A discharge above the permitted level or probable discharge of oil or of noxious liquid substances for whatever reason including those for the purpose of securing the safety of the ship or for saving life at sea; or 2. A discharge or probable discharge of harmful substances (see note) in packaged form, including those in freight containers, portable tanks, road and rail vehicles and shipborne barges; or 3. Damage, failure or breakdown of a ship of 15 metres in length or above which: (a) affects the safety of the ship; including but not limited to collision, grounding, fire, explosion, structural failure, flooding and cargo shifting; or (b) results in impairment of the safety of navigation; including but not limited to, failure or breakdown of steering gear, propulsion plant, electrical generating system, and essential shipborne navigational aids; or 4. A discharge during the operation of the ship of oil or noxious liquid substances in excess of the quantity or instantaneous rate permitted under the present Convention.	MARPOL 1973/1978	Incident reports (STEMS)	
Ensure that sanitary wastewater in the port management area does not contaminate groundwater or coastal water to the extent that health problems arise.	*Health Act 1911* (WA)	Incident reports (STEMS). No complaints from external parties in relation to health matters or sewage disposal.	
Report sites that are suspected to be or known to be contaminated.	*Contaminated Sites Act 2003* (WA)	Registration of known or suspected contaminated sites with DER. Correspondence with Contaminated Sites Branch of DER.	
Manage certain declared plants (weeds) if identified on BrPA land.	*Biosecurity and Agriculture Management Act 2007* (WA)	Identification of weeds in Aspects and Impacts Register and corresponding entry/entries in RiskBase with controls to manage.	

Legal or Other Requirement	Source and Jurisdiction	Evidence Required for Compliance	Evaluation of Compliance
BrPA is required to refer proposals to the Department of Environment that appear likely to have significant impact upon a matter of national environmental significance (MNES). The EPBC Act identifies a number of MNESs, including: – World Heritage properties; – National Heritage places; – Wetlands of International importance; – listed threatened species and communities; – listed migratory species; – water resources in coal seam gas projects; – Commonwealth marine areas and land; and – nuclear actions.	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)	Referrals to the Department of Environment or documentation supporting decisions not to refer, e.g. risk assessments, memos or emails (where applicable). No unassessed projects with significant impacts to MNES.	
Ensure BrPA operations do not cause the taking (includes disturbance and harassment) of whales, dolphins, seabirds and other protected species.	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)	Incident reports (STEMS). No report of EPBC Act listed fauna species.	
Not to discharge to the sea from any oil, oily mixture, noxious substance, packaged harmful substance or garbage from any BrPA owned vessels.	*Protection of the Sea (Prevention of Pollution from Ships) Act 1983* (Cth)	Incident reports (STEMS). No complaints about spills from external parties.	
Not to dump any wastes or other matter (including dredge spoil or derelict vessels) into coastal waters or into port waters, unless in accordance with a sea dumping permit.	*Environment Protection (Sea Dumping) Act 1981* (Cth)	Incident reports (STEMS). Waste disposal records. No complaints about spills from external parties.	
While this Act and the associated Department of Agriculture Work Instructions can influence port operations with respect to vessel berthing, access and ballast water discharges, the BrPA does not have direct responsibly for quarantine.	*Quarantine Act 1908* (Cth)	(Not applicable.)	

Environmental Management Procedure

Activity: Fuelling Operations (Bunkering) at the Jetty

Objective:

- Prevent fuel spills and leaks from fuelling operations (bunkering) at the jetty.

Relevant Activities:

- Small to medium size vessel fuelling (bunkering).

Environmental Management Procedures:

- Fuel dispensing equipment should be equipped with dry break hose couplings.
- Valves should remain in shut position unless manually opened during fuelling.
- Use quick closing shut off valves.
- Provide drip trays under hose connections and couplings.
- Dispose of water, collected in fuel bowser catch basin, as if it were oily water.
- Provide spill response kits at all fuelling points.
- Use absorbent materials and spot cleaning for small spills, do not hose down the area.
- Dispose of absorbent materials in an approved manner.
- Properly dispose of any fuel spills and leaks.
- Conduct leak detection tests on fuel systems including distribution lines.

Likely Pollutants:

- Petroleum hydrocarbons.

Environment at Risk:

- Marine waters.

Environmental Management Procedure

Activity: General Cargo Handling (other than dust generating activities, hazardous waste and livestock)

Objective:

- Prevent release of solid waste from vessels and jetty.

Relevant Activities:

- General cargo handling.

Environmental Management Procedures:

- Ensure cargoes are adequately identified and correctly marked.
- Minimise storage and retention of cargoes on jetty.
- Ensure cargo-packaging materials are collected and properly disposed off.
- Ensure overseas packaging materials (of biological origin) are adequately disposed off according to quarantine regulations.
- Retrieve solid waste and other materials deposited into the sea from the jetty.
- Ensure cargo handling equipment is adequately maintained.

Likely Pollutants:

- Solid waste/litter including plastic.

Environment at Risk:

- Marine waters.

Considerations:

- Conduct frequent inspection of storage and handling areas and handling equipment.
- Keep consistent and accurate records of inspection efforts.
- Storage structures should be designed to meet local and state fire codes.

Environmental Management Procedure

Activity: Cargo Handling - Dust Generating Materials

Objectives:

- Prevent emissions of dusts and entrainment of sediments in marine waters from dry bulk handling activities.

Relevant Activities:

- Handling of dust generating materials such as grain, bentonite and fertilisers.

Environmental Management Procedures:

- Cover storage and handling facilities where practicable.
- Adoption of dry break hoses by contractors to transfer bulk products from taker to vessel.
- Utilise dust suppression mechanisms
- Utilise water sprays where practical.
- Minimise free fall of materials by installing telescoping arm loaders.
- Use slurry transport where feasible.
- Minimise stockpile heights.
- Install filtering mechanisms in storm drain system on deck to minimise transport of solids to marine waters.
- Ensure transport vehicles are covered whenever possible.
- Ensure hatches are covered when material handling is not being conducted.
- Conduct routine vacuum sweeping of wharf and handling areas.
- Clean up spills immediately.
- Avoid loading/unloading during windy conditions.
- Conduct routine sweeping of truck storage areas and roadway surface.

Likely Pollutants:

- Dust, sediments, metals, hydrocarbons and salts.

Environment at Risk:

- Surface water and air.

Considerations:

- Provide training on handling and transport techniques for minimising dust pollution.
- Develop routine inspection and maintenance program and keep records of activities.
- Costs may be very high for installation and maintenance of covered handling areas or additional dust suppression facilities.

Environmental Management Procedure

Activity: Ship and Shore Generated Solid Waste Handling

Objectives:

- Prevent discharge of contaminants associated with solid waste handling.

Relevant Activities:

- Solid waste collection.
- Solid waste handling.
- Solid waste disposal.

Environmental Management Procedures:

- Cover waste storage facilities to prevent rainwater from carrying contaminants off the jetty, to reduce loss due to wind and exclude birds and vermin.
- Ensure drain plugs are closed.
- Bund relevant areas to prevent contaminants entering the stormwater system.
- Clearly mark facilities indicating what materials are acceptable for disposal.
- Provide separate receptacles for hazardous waste materials (e.g., batteries, paints and solvents).
- Provide receptacles for recyclable materials (e.g. aluminium, paper, including cardboard, glass).
- Provide suitable disposal facilities and procedures for quarantine waste.
- Ensure that receptacles are easily accessible.
- Monitor materials placed in receptacles, remove batteries, containers with solvents and paints, and other hazardous wastes.
- Empty waste receptacles frequently.
- Ensure all disposal areas are properly lighted to reduce chances of incorrect disposal.
- Develop information packages designed for ship masters:
- Identifying waste reception facilities.
- Identifying acceptable handling procedures.
- Encouraging recycling.

Likely Pollutants:

- Litter including plastics.
- Contaminated water.
- Land, surface water, groundwater and marine environment.

Environmental Management Procedure

Activity: Ship and Shore Generated Solid Waste Handling (cont'd)

Environment at Risk:

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Environmental Management Procedure

Activity: Ship Air Emissions

Objectives:

- To reduce the discharge of pollutants to the air from operation of ships.

Relevant Activities:

- Ship operational air emissions.

Environmental Management Procedures:

- Provide onshore power for vessels to reduce shipboard power use while alongside.
- Encourage vessels to shut down power plants if berthed for more than six hours (assuming suitable shore supply is available).
- Encourage ship captains to reach appropriate distances off shore before achieving full power.
- Encourage ship operators to keep onboard engines in good working order to reduce emissions.
- Encourage ship operators to keep transfer equipment, e.g. cranes, forklifts, trucks, in good working condition to reduce emissions.
- Prohibit blowing tubes in Port.
- Set speed limits for manoeuvring near shore.
- Encourage alternative fuels and fuel mixtures.

Likely Pollutants:

- Nitrogen oxides, carbon dioxide, sulphur dioxides, particulates and hazardous air pollutants.

Environment at Risk:

- Air.

Considerations:

- Providing onshore power supplies will be expensive.
- Restarting diesel engines may release significant levels of pollutants.

Environmental Management Procedure

Activity: Vessel Repair and Maintenance

Objectives:

- Prevent or reduce pollution releases during vessel repair and maintenance activities.

Relevant Activities:

- Vessel maintenance and repair activities.

Environmental Management Procedures:

- Discourage in-water hull cleaning, paint removal and spray painting.
- If in-water maintenance is conducted, ensure all reasonable measures to limit and capture paint chips and other waste generate by the activity.
- If using slipway, ensure paint and paint residues are prevented from entering the marine environment.
- Do not apply anti fouling paints to vessels in the water.
- Use tarps and fixed covers to prevent storm water from carrying wastes into surface waters.
- Remove fluids from operating equipment before conducting maintenance.
- Provide facilities to handle the volume of waste fluid expected.
- Keep fuels, lubricants, coolants and paints separate from each other and other chemicals.
- Store and handle chemicals as discussed in the Chemical Storage Guidance Card.
- Clean up spills as they occur.
- Have spill response gear available.
- Keep equipment as clean as possible.
- Clean equipment frequently to prevent build up of contaminants.
- Conduct frequent maintenance to reduce leaks and spills.
- Remove and dispose of asbestos in accordance with regulations.
- Dispose of lead based paint residues in accordance with regulations.

Likely Pollutants:

- Hazardous material (organotins, PCBs, asbestos, lead based paints).
- Chemicals including hydrocarbons, detergents, paints and antifoul coatings (non-organotin).

Environmental Management Procedure

Activity: Vessel Repair and Maintenance (cont'd)

Likely Pollutants (cont'd):

- Solid waste/litter including plastics.
- Dust and paint chips.

Environment at Risk:

- Air. land, surface water, groundwater and marine environment.

Environmental Management Procedure

Activity: Maintenance of the Jetty and Navigation Aids

Objective:

- Prevent discharge of pollutants from painting or paint stripping operations performed on navigation aids, equipment, jetty and any other structures associated with port activities.

Relevant Activities:

- Painting of navigation aids, moorings and jetty.
- Painting of yard equipment.
- Paint stripping using abrasives or water blasting.

Environmental Management Procedures:

- Designate special areas for painting and paint stripping.
- Design areas to minimise or contain accidental releases.
- Pave surfaces, preferably with concrete to allow easier removal of spills or stripping material.
- Slope surface to allow capture of spills.
- Use valved catch basins that allow spills and releases to enter a dead-end sump.
- Use sand filters to capture spills and runoff of paint stripping operations.
- Use berms to minimise run-on of stormwater.
- Use paint booth to capture air emissions.
- Provide used paint disposal facilities.
- Provide paint stripping debris disposal area.
- Paint stripping/painting area should be covered if possible.
- Clean up stripping wastes immediately to reduce potential dispersal by wind or into the stormwater system.
- Provide screens and filter to capture residue generated when conducting maintenance to jetty or navigation aids in-situ.
- Minimise volume of paints and chemical strippers purchased and stored to minimise waste.
- Install windscreens and solids collection screens.
- Use tools and procedures designed to capture stripping materials
- Minimise amount of material subject to wind or rain.
- Use drop cloth under stripping and painting operations on unpaved surfaces.
- Vacuum or sweep paved surfaces regularly.

Environmental Management Procedure

Activity: Maintenance of the Jetty and Navigation Aids (cont'd)

Environmental Management Procedures (cont'd):

- Do not hose down work area.
- Mix materials away from the water.
- Reuse solvents and thinners.

Likely Pollutants:

- Hazardous material (organotins, PCBs, asbestos, lead based paints).
- Chemicals including hydrocarbons, solvents, thinners, strippers, detergents, paints and antifoul coatings (non-organotin).
- Solid waste/litter including plastics.
- Dust and paint chips.

Environment at Risk:

- Air. land, surface water, groundwater and marine environment.

Considerations:

- All waste materials must be disposed of properly.
- Spills and releases should be reported immediately.
- Maintain adequate supplies of spill response equipment.
- Provide spill response training to all personnel.
- Provide training on operating and cleaning procedures.
- Conduct routine maintenance of equipment.

Environmental Management Procedure

Activity: Waste Oil Management

Objective:

- Prevent release of pollutants from the handling and storage of waste oil in 205 L drums or smaller containers.

Relevant Activities:

- Storage, handling and transport of waste oil.

Environmental Management Procedures:

- Cover all waste oil storage areas and ensure adequate ventilation in cases of spills and leaks.
- Raise storage area above surrounding ground surface and berm to minimise contaminants entering stormwater systems and to contain leaks and spills.
- Provide an impervious base in storage and handling areas to minimise releases to soils and groundwater.
- Contain and properly dispose of leaks and spills from within berm and/or existing enclosed storage sheds.
- Seal joints and cracks.
- Protect storage areas from vehicle accidents.
- Restrict access to storage areas through the use of fencing or enclose storage areas.
- Ensure storage areas are clearly marked noting material stored, emergency contacts, and spill cleanup procedures.
- Ensure all containers are adequately closed and sealed prior to transport from the jetty to the maintenance yard.
- Ensure all containers are securely loaded and tied down prior to transport.
- Avoid transfer of waste oil (from small containers or bunds into drums) in close proximity to drainage areas.
- Provide secondary containment for all active drums and consider connecting an oil/water separator to the decanting area.
- Contain and properly dispose of waste from secondary containment.
- Immediately contain and stop leaks and spills.
- Have spill response materials readily available, in strategic locations for use in any location.
- Clearly mark spill response materials.

Likely Pollutants: ▪ Hydrocarbons (waste oil).
Environment at Risk: ▪ Land, surface water, groundwater and marine environment.

Environmental Management Procedure

Activity: Chemical Storage and Handling

Objective:

- Prevent release of pollutants from the handling and storage of chemicals in 205 L drums or smaller quantities.

Relevant Activities:

- Storage and handling of chemicals.

Environmental Management Procedures:

- Cover all chemical storage areas.
- Provide adequate ventilation in cases of spills and leaks.
- Raise storage area above surrounding ground surface and berm to minimise seepage into surrounding areas and into the stormwater system.
- Provide an impervious base in storage and handling areas to minimise releases to soils and groundwater.
- Seal joints and cracks.
- Protect storage area from vehicle accidents.
- Restrict access to storage areas through the use of fencing or enclose storage areas.
- Provide flame-resistant containers where required.
- Use flame resistant locker for small quantities of materials.
- Ensure only compatible materials are stored together.
- Maintain, read and understand material safety data sheets (MSDS) for all chemicals.
- Minimise quantities of materials stored.
- Provide designated separate area for leaking hazardous products, that is:
  - Covered and ventilated.
  - Dead-end sumped to contain spills and leaks.
  - Bermed to prevent spread of spills and leaks.
  - Impervious based.
- Ensure all containers are marked and labelled properly. Ensure storage areas are clearly marked noting materials stored, emergency contacts, and spill cleanup procedures.
- Maintain copies of relevant MSDSs in a location near to but separate from chemical storage facility.

Likely Pollutants:

- Various chemicals including hazardous chemicals.

Environment at Risk:

- Land, surface water, groundwater and marine environment.

Environmental Management Procedure

Activity: Miscellaneous Storage

Objective:

- Prevent or reduce the release of environmental contaminants during storage of miscellaneous materials in the maintenance yard.

Relevant Activities:

- Scrap metal storage.
- Treated timber storage.
- Hazardous material (e.g. PCB, asbestos) storage.

Environmental Management Procedures:

- Provide covered storage for oily scrap materials.
- Provide covered storage space for hazardous materials (e.g. PCBs, asbestos, lead paint, TBT)
- Storage areas should be paved where possible.
- Provide storm water runoff controls for storage areas.
- In uncovered storage areas consider installing an oil/water separator to remove floating waste and detention system to remove sediments and metal particles.
- Provide berms/dikes around storage areas to minimise run on of stormwater.
- Empty stored equipment of fluids (e.g. fuel and lubricants) unless required for preservation.
- Conduct routine inspections to identify and remove leaking equipment.
- Clean storage areas frequently.
- Remove dust and spills.
- Identify asbestos containing materials.
- Remove asbestos in accordance with relevant regulations.
- Remove and dispose of remaining sand blast residue in accordance with relevant regulations.
- Identify any PCB containing materials stored in the area.
- Remove PCB containing materials in accordance with regulations.
- Minimise contact of treated timber with surface water and ground water.

Likely Pollutants:

- Hydrocarbons.
- Various metals including lead, nickel etc.
- Arsenic from treated timber.
- Hazardous material/chemicals including organotins, PCBs and asbestos.

Environment at Risk:

- Land, surface water, groundwater and marine environment.

Environmental Management Procedure

Activity: Building and Grounds Maintenance

Objective:

- Prevent or reduce the discharge of pollutants from building and grounds maintenance.

Relevant Activities:

- Grounds maintenance.
- Herbicide/pesticide use.
- Building maintenance.

Environmental Management Procedures:

- Minimise use of pesticides, herbicides, and fertilisers and use only as directed. Seek less harmful/toxic products to replace ones currently used.
- Provide adequate storage space for pesticides and herbicides, and ensure well ventilated.
- See Chemical Handling guidance card for recommendations on chemical storage and handling.
- Exercise proper precautions when applying materials near water bodies or stormwater systems.
- Utilise integrated pest management where appropriate
- Properly dispose of green waste, wash water, sweepings, and sediments.
- Use “dry” cleaning techniques, such as sweeping, whenever possible.
- Incorporate landscaped areas that are pervious and will result in less runoff discharged from a site.
- Incorporate native vegetation to reduce irrigation, fertiliser, and pesticide needs.
- Conduct fluorescent light ballast recycling program.
- Carefully manage asbestos according to regulations.
- Carefully manage lead paint according to regulations.
- Electrical equipment should be inspected to determine if PCBs are present.
- If PCB containing equipment is in use, it should be inspected regularly for leaks.
- Worn or leaking equipment should be replaced immediately.
- Dispose of PCBs and equipment contaminated by PCBs in accordance with regulations.

Likely Pollutants:

- Pesticides, herbicides, fertilizers.
- Paints, solvents, thinners and strippers.
- Litter including plastics.
- Hazardous material including PCBs and asbestos.

Environment at Risk:

- Land, surface water, groundwater and marine environment.

Environmental Management Procedure

Activity: Vehicle and Equipment Maintenance

Objective:

- Prevent the discharge of pollutants during vehicle and equipment maintenance activities.

Relevant Activities:

- Vehicle maintenance.
- Equipment maintenance.
- Vehicle equipment painting/stripping.

Environmental Management Procedures:

- Move maintenance activities indoors, or provide cover over work area where possible.
- Provide run off controls that minimise run off into stormwater systems and into the maintenance yard
- Use designated vehicle washing and parts degreasing area. This area should be equipped with runoff controls.
- Use drip pans and absorbent pads at potential problem areas. Clean up spills as they occur.
- Remove absorbent pads from area after use and dispose of in an appropriate manner.
- Provide adequate space for storage of chemicals and waste products.
- Drain and crush oil filters (and oil containers) before recycling or disposal.
- Store crushed oil filters and empty lubricant containers in a leak-proof receptacle.
- Label storm drain inlets “Storm drain. No dumping”.
- Do not hose down work areas to the storm drain, or use concrete cleaning products unless the storm drain inlet is blocked and washwater is collected and properly disposed.
- Keep equipment clean and perform maintenance in suitable areas.
- Eliminate excessive amounts of external oil and grease build-up.
- Use non-chlorinated solvents and cleaning agents.
- Use mops, dry sweeping compounds, or contract professional cleaning services.
- Store mechanical parts and equipment that may yield even small quantities of contaminants (i.e. oil and grease) under cover.

Likely Pollutants:

- Chemicals including hydrocarbons and coolants.
- Litter including plastics.

Environment at Risk:

- Land, surface water, groundwater and marine environment.

Environmental Management Procedure

Activity: Stormwater, Erosion and Dust Control

Objective:

- To control stormwater movement in order to prevent or reduce soil erosion and the transfer of contaminated sediment to the marine environment.

Relevant Activities:

- Repair of existing disturbed areas.
- Development of new areas.
- Control of runoff.

Environmental Management Procedures:

- Identifying stormwater pathways and volumes.
- Determining the extent of currently eroded areas.
- Identifying erosion problem areas.
- Develop a stormwater and erosion control plan.
- Consider the use of structural stormwater and erosion control devices including: earth dikes, drainage swales, interceptor dikes and swales, subsurface drains, silt fences, straw bale barriers, brush barriers, and gravel or stone filter berms.
- Plant native grasses, shrubs, or ground cover plants in drainage pathways to slow erosion.
- Incorporate storm water detention/retention to reduce peak runoff flows and to improve water quality.
- Plant native grasses, shrubs, or ground cover plants to slow erosion.
- Use mulch on disturbed soil.
- Provide cover of gravel, wood chips, or straw will help to minimise erosion processes.
- Consider use of netting or mats as a supplement to mulching.
- Control dust during dry weather by watering disturbed areas.

Likely Pollutants:

- Contaminated sediment.

Environment at Risk:

- Marine environment.

Environmental Management Procedure

Activity: Protection of Marine Mammals and Sensitive Aquatic Habitats

Objective:

- Protect marine mammals and other sensitive marine life from ship vessel, ship berthing procedures, and other port activities.
- Protect sensitive habitats from port activities.

Relevant Activities:

- Management of ships and small watercraft.

Environmental Management Procedures:

- Identify species and biological communities of concern (e.g. marine mammals, seabirds, coral reefs) and their seasonal occurrence in port waters.
- Determine location and extent of species habitat within port waters.
- Determine species habitats such as feeding and nursing areas and migration patterns as applicable.
- Develop procedures for sighting and avoiding species at risk.

Likely Pollutants:

- Various chemicals.
- Noise pollution.
- Light spill from night lighting.
- Litter including plastics.

Environment at Risk:

- Marine species of conservation significance likely to be found in port waters are turtles, dugong and whales, particularly humpback whales from July to October.

Environmental Management Procedure

Activity: Public Access and Recreation

Objective:

- Provide for public access to the jetty for pedestrian users and recreational boating while preventing releases of pollutants associated with the use of these areas.

Relevant Activities:

- Solid waste disposal.
- Fishing waste disposal.
- Sewage disposal.
- Contaminated bilge water disposal.

Environmental Management Procedures:

- Provide adequate parking.
- Provide adequate signage denoting safety and access requirements.
- Provide public restrooms.
- Provide space for fish cleaning, ideally a covered bench area with sink and with drain connected to sewage system.
- Provide adequate solid waste disposal facilities.
- Encourage recycling.
- Encourage use of onshore restroom facilities instead of on board heads when alongside.
- Provide contaminated bilge water disposal options including low cost or no cost absorbent pads.
- Provide disposal containers for used pads.
- Provide waste oil collection facilities.
- Discourage vessel maintenance activities. If vessel maintenance activities do take place, follow guidance provided in Vessel Repair and Maintenance guidance card.

Likely Pollutants:

- Putrescible wastes.
- Sewage.
- Hydrocarbons.
- Litter including plastics.

Environment at Risk:

- Land and marine environment.

Environmental Management Procedure

Activity: Land Clearing

Objectives:

- To reduce the impact of clearing native vegetation and ensure that no unauthorised vegetation clearing occurs inadvertently.
- To preserve fauna habitat wherever possible.
- To minimise impacts to priority, declared rare or conservation significant flora species occurring within the PMA.
- To identify opportunities to utilise topsoil and cleared vegetation to rehabilitate disturbed areas within the PMA that are not required for development.
- To prevent and/or minimise the introduction and spread of weeds within the PMA.

Relevant Activities:

- Vegetation clearing and earthworks required for the project footprint.
- Stripping and stockpiling vegetation and soil.
- Rehabilitation of disturbed areas not required for operations.

Environmental Management Procedures:

- Obtain a Permit to Take under the WC Act before any DRF are cleared.
- Seek approval from local indigenous groups and the Kimberley Land Council prior to removing culturally significant flora.
- Keep vegetation clearing and earthworks to the minimum necessary for safe construction and operation of the proposed facilities, with the preferential use of previously disturbed or degraded areas where available.
- Prior to clearing, clearly mark out the proposed clearing boundary with green flagging-tape. The project manager will then approve the marked-out area before clearing commences.
- Prior to clearing, clearly mark environmentally and culturally significant flora that have not been approved for clearing with pink flagging-tape. The project manager will then instruct personnel to avoid any area marked in this manner.
- Establish and maintain firebreaks around any vegetation stockpiles.
- Carry out progressive rehabilitation, where possible (e.g., of temporary tracks).
- Undertake compulsory site inductions to ensure that personnel have an awareness of significant environmental and social values and relevant field procedures.

Environmental Management Procedure

Activity: Land Clearing (cont'd)

Environmental Management Procedures (cont'd):

- Regularly undertake dust suppression during clearing or any other activity that generates visible dust to minimise potential dust-related impacts on adjacent vegetation communities.
- Make sure all ground-engaging, earthmoving and tracked equipment is cleaned prior to arrival on-site to help prevent the introduction and spread of weeds.
- In advance of clearing, spray or otherwise treat any established weed populations in areas used for topsoil or vegetation stockpiles.
- Prior to clearing, identify any disturbed or degraded areas that would benefit from the grafting of high quality topsoil and ensure direct transfer of high quality topsoil occurs during the clearing process. High quality topsoil is defined as that supporting native vegetation in good condition and free of weeds and any other form of contamination.
- Where direct transfer of topsoil is not possible, store in stockpiles for future use. These stockpiles will be no taller than 1.5 m and clearly marked in the field and on the site plan.
- If available, place large rocks and logs in rehabilitated areas to encourage fauna recolonisation.
- Do not burn cleared vegetation. Use cleared vegetation to cover topsoil stockpiles. If there is cleared vegetation in excess of these requirements, remove it from site.
- Recontour all disturbed areas not required for operational purposes and use shallow ripping to alleviate any compaction, provide a niche for seed and help control surface water.
- Remove contaminated soil and other such material and dispose to a licensed facility.
- Detain surface-water runoff from cleared areas in sedimentation ponds prior to release to the environment.
- Prohibit vehicle access outside of designated areas.
- Conduct regular field inspections to audit the areas cleared against the approved clearance areas. Any unauthorised clearing will be reported to the DER.

Likely Pollutants:

- Hydrocarbons.
- Herbicides.
- Dust.

Environment at Risk:

- Flora and vegetation (specifically, the conservation significant taxa *Keraudrenia exastia* and flora of significance to indigenous heritage).
- Fauna and habitat.

- Indigenous heritage.

Environmental Management Procedure

Activity: Management of Environmentally and Culturally Sensitive Areas

Objective:

- To manage and minimise the impact of port activities on environmentally and culturally sensitive areas.
- To preserve fauna habitat wherever possible.
- To minimise impacts to priority, declared rare or conservation significant flora species occurring within the PMA.
- To prevent and/or minimise the risk of the introduction and spread of weeds within the project area.

Relevant Activities:

- Maintenance of designated areas for conservation purposes.

Environmental Management Procedures:

- Maintain data on known locations of all significant flora within BrPA records.
- Clearly signpost all environmentally and culturally sensitive areas.
- Ensure all DRF occurring within environmentally and culturally sensitive areas are protected by a 50 m buffer between it and the edge of the area. In areas where DRF occur less than 50 m from the edge, erect fencing to prevent access.
- Control any established weed populations occurring within or near environmentally or culturally sensitive areas.
- Inspect environmentally and culturally sensitive areas annually to determine if further management actions are required. Maintain records of inspections.
- Prohibit all off-road vehicle movement in environmentally and culturally sensitive areas except where approved by the BPA.
- Ensure all personnel have an awareness of environmentally and culturally sensitive areas through site inductions.
- Suppress dust in areas adjoining environmentally and sensitive areas to ensure the impact on vegetation within those areas is minimised.
- Control feral animals.
- Investigate methods by which *Keraudrenia exastia* (DRF) can be propagated, in consultation with DPaW, with a view to establish additional populations of the species.

Likely Pollutants:

- Herbicides.
- Dust.

Environment at Risk:

- Flora and vegetation (specifically, the conservation significant taxa *Keraudrenia exastia* and flora of significance to indigenous heritage).
- Fauna and habitat.
- Indigenous heritage.

Environmental Management Procedure

Activity: Livestock Handling

Objective:

- Reduce risk of harmful environmental effects associated with animal odour, noise and waste.

Relevant Activities:

- Handling of livestock

Environmental Management Procedures:

- Minimise livestock waiting time on jetty (will help minimise livestock odour, noise and waste).
- Ensure animal waste does not accumulate on jetty and that waste is disposed at designated waste dump.
- Clearly mark facilities indicating what materials are acceptable for disposal.
- Design new facilities to:

  Minimise release of animal waste to surface water.

  Minimise release of stockfeed to surface waters.
- Ensure livestock trucks are not washed down in the PMA.

Likely Pollutants:

- Odour
- Animal wastes
- Stockfeed

Environment at Risk:

- Surface water and air.

Legal Considerations:

- Department of Environment Regulation licence requirements; compliance is audited annually.

Considerations:

- Maintain register of major releases of animal waste and stockfeed into marine waters.